Sciothericum Teleſcopicum;

OR,

A New Contrivance of Adapting a

TELESCOPE

TO AN

Horizontal Dial

FOR OBSERVING

The moment of Time by Day or Night.

Uſeful in all *Aſtronomical Obſervations*, and for Regulating and Adjuſting

Curious *Pendulum-Watches* and other *Time-Keepers*, With proper *Tables* Requiſite thereto.

By *William Molyneux* Eſq; *Fellow* of the *Royal Society*, and of that in *Dublin*.

DUBLIN,

Printed by *Andrew Crook* and *Samuel Helſham*, for *William Norman*, *Samuel Helſham* and *Eliphal Dobſon* Bookſellers. 1686.

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THat the laſt Leaf in the Sheet *L* of the Tables is to be Cut off, and turned, and the ſide marked with the Star is to be placed next to the ſixth Page.

TO HIS EXCELLENCY
Henry Earl of Clarendon, LORD Lieutenant General, AND GENERAL GOVERNOUR OF His MAJESTIES Kingdom OF IRELAND.

THE great Honour Your Excellency *was pleased to shew Our Society in accepting Our Congratulation at Your happy Arrival and Settlement in the Government of this* Kingdom, *and in giving us Your Incouragement in prosecuting our* Philosophical Designs, *does*

does necessarily require from us all possible Returns of Gratitude. *And though what I now Present Your* Excellency *may seem unfit to begin withal, yet I could not omit this* opportunity *of expressing to* Your Lordship *the deep sense I have of* Your Favours *to us, and to* Philosophy. *And certainly, my Lord,* True Philosophy *does highly deserve Encouragement from the* Wise, *the* Great, *and* Powerful; *the most* Learned Universities *have at all times made* Natural Philosophy *and* Mathematicks *a great Branch of their* Literature, *and we see how universaly* Academick Knowledge *has been approved of by the great* Encouragement *and large* Priviledges *the* Schools *have received from our* Wisest Princes, *and by the general agreement of the most* sober *and* considerate men, *in sending their Youth to receive their* Education *therein. This shews how universaly* Philosophick Learning *has been approved; and the only Question that can be raised at present is, Whether the* Natural Philosophy *formerly professed in the* Schools, *or that which is at present prosecuted by the* Societies *lately* Instituted *in several the most noted parts of* Europe, *be the* True Philosophy, *or method of* Investigating Nature. *But surely this will be no longer a doubt, when we consider how unsatisfactory were the* ancient Notions of Philosophy, *which then consisted rather in* Disputes, *and* Verbose *empty* Stuff, *than in any Curious Discovery of* Natures Actions. *If a man could prove* Pro *and* Con, *whatever was proposed, and main-*

tain this Dispute *for two or three hours by vain* Distinctions *and idle* Evasions, *he presently gain'd the Name of a* Philosopher, *tho all the while he had no manner of* Notions *in his Brain answerable to those senseless words he threw out. I would fain know, what* Notion *any man has of* Light *upon pronouncing the* definition *of it*, Actus Perspicui quatenus Perspicuum, *does he hereby in the least understand any of the* properties *of* Light, *or how 'tis affected by* Refraction *or* Reflection? *or does this* Definition *lead him to improve* Light *for the advancement and help of our senses, or other* advantage *of* mankind? *And now,* my Lord, *if this kind of* Philosophy *which formerly fill'd our Schools were look'd upon as deserving the* Favour *of the* Great, *how much more shall the present useful* Enquiries *of the* Ingenious *deserve* Incouragement? *But that this may be made a little more evident (though I am perswaded 'tis sufficiently manifest already to* Your Excellencys *Discerning Judgment) I shall crave leave to be more particular in this matter; And I shall begin with one of the most Considerable and Universal Concerns of* Mans Life, *I mean* Navigation, *wherein the* Philosophy *of the* Moderns *has been very much Exercised; The* Magnet *by its* Caprichious *Variations is at present in several parts of the World rendred almost useless; but diligent search is daily made after its* Vagarys, *that we may not be deprived of the unspeakable benefit of one of the most surprising* Phenomenas *in Nature. Certainly men might*

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have Disputed from Age to Age of Sympathy, Antipathy, *and the* Occult Qualities *of the* Loadstone, *before they should ever arrive to the* Knowledge *or* Rectification *of one of these* Exorbitances, *which diligent* Experimental Philosophy *presently discovers, and further Experiments may hope to Rectify.* In *relation likewise to* Navigation *are all the Enquiries into the* Theory *of the* Tides, *and the* Moons motion, *all the Endeavours for the* Longitude, *and the Diligence used to Rectify* Astronomy. *The* Philosophy *of* Hydraulicks *and* Hydrostaticks *tends to the great* Emolument *and* Pleasure *of Mankind, no place being habitable without Water, and Curious Fountains adorn the Gardens and Houses of the Greatest Princes.* Agriculture, *and the* Philosophy *relating to Earth and* Vegitation, *is of universal extent over the face of the World; and how mightily it has been lately prosecuted, is evident from the Incomparable Works of Mr.* Evelyn *and others. By the* Doctrine of Light, *and the Properties thereof, our most Noble Sense has been Improved to an Acuteness some thousands of degrees beyond its natural Abilities; and the* Telescope *and* Microscope *discover to us new* Worlds *and* Animals, *extending the Creation farther than 'twas possible for the Ancients to imagine. There is no state of Life that is not concern'd in* Meteorology, *or the* Philosophy of the Weather. *And all that have heard of the late contrived* Baroscopes, Hygroscopes, Thermoters, *&c. may plainly perceive what Endeavours have been made towards it, and their success.*

I might

I might proceed on, and fill a Volume with Instances to Your Excellency *of the usefulness of an Active* Experimental Philosophy, *but I stop my hand, and shall only declare in short, that from this alone we are to expect advancements in the most important concerns of humane life; the Virtues of* Animals, Plants *and* Minerals *for the health of mans Body,* Architecture *Civil and Military for the pleasure and security of his life; all kind of* Machines *and* Movements *for the increase and due application of his strength, proceed from this kind of* Philosophy, *which consists in Actions, not in Words, and prosecutes and sometimes* improves Nature *by the same steps that she her self acts by. And indeed, my Lord, if we consider* Nature *as an Active Principle, we must needs acknowledge that she is to be prosecuted by* Action, *and not by* Verbose Disputes; *There is nothing that the mind of man will not find something to say for or against all day long; and therefore of the School-Disputes there is no end; but Experiment is matter of Fact, and strikes the Senses so forcibly, that there is no opposing it. Who is it that will now question the force of* Gun-powder, *or whether the* Mercury *rise and fall in the* Baroscope *at fair or foul Weather?*

'Tis therefore this Philosophy (may it please Your Excellency) *that deserves* Favour *and* Incouragement *from the* Powerful *and* Wise; *and as God has made all things in* number, measure, *and* weight, *that* Learning *which teaches us the affections*

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of number *and* measure, *as being the Foundation on which* true Philosophy *is to be superstructed, is chiefly to be respected. There is no part of* Philosophy *wherein the* Mathematicks *are not deeply ingredient, and on them depend the* Arts of War *as the* Delights of Peace, *and even Sacred* Theology *it self is in a great measure beholding hereto for its help, if we consider how far the* Chronology *of the* Holy Scriptures *is help'd out by* Astronomy, *and the Doctrine of* Eclipses.

And as I have presumed to detain Your Excellency *thus long, in declaring how* true Philosophy *deserves Your* Protection, *so give me leave to add one word more in declaring how* Your Excellency *deserves the* Tutelage *of true* Philosophy. *Your* Illustrious Father, *of Happy Memory, was no unactive* Speculative Philosopher, *but was zealons and forward in promoting the Noble Design of the* Royal Society, *as appears to his immortal Praise in their* Incomparable History, *and by their Electing him, and his willing Complyance to be their* Protector. *Neither did he only countenance* Philosophy *by his* Authority *and* Favour, *but actually drew the Sword in its defence against the great* Sea Monster *that would have destroy'd the* Virgin; *as is manifest from his* Learned *and* Ingenious Treatise *against the* Leviathan. *All the World that know* Your Lordship, *must acknowledge that this and other his extraordinary* Virtues *are entail'd on* Your Excellency, *who has not buried the* Talent *in a* Napkin, *but improved*

it

it to an high degree. Your Excellency *has Honoured the* Royal Society *by being one of them Number, and their* last years Council *was compleated by* Your *being one of them. So that upon all occasions* Your Excellency *has shewn* Your Self *a zealous* Patron *of* Learning *and* Ingenuity; *and though I dare not on either score challenge* Your Excellency's Protection *of what I here present You, for I am afraid to trust my own Judgment in my own Concern; yet I will presume to implore* Your Favour *towards it as 'tis new, and not disliked by some* Ingenious Men *to whom I have shewn it. Whether it may deserve* Your Excellency's *Countenance for its Use and Advantage, I leave to Your own discerning Thought, after* Your Lordship *is pleased to consider what I offer in the First and Second Chapters. However, this I will venture to assert before-hand, that as* Clocks *or* Time-keepers *by Wheels and Weights have been an ancient Invention, (if we believe* Severinus Boethius *to be the first Author of them, 'tis above* 1100 *years ago) yet in these later days they have received a most high advancement (to the immortal glory of* Mnsr. Hugens) *by the addition of a plain and simple* Swag *or* Pendulum; *since the days of* Hezekiah, *wherein we first find* Dials *mentioned, I have not heard of a more plain and easy addition for the advancement of* Dials, *and inlarging and ascertaining their Use, than what I here propose. And though I shall not be so vain, as to expect its sudden propagation, or any great Glory from the Contrivance;*

vance; yet if I can be so happy as thereby to Divert and Please Your Excellency, *and in some measure to purchase Your Favour, 'tis the highest Ambition of*

Your Excellencies

Dublin, April 17. 1686.

Most Obedient Humble Servant,

WILL. MOLYNEUX.

Sciothericum Telescopicum,

OR,

A New Contrivance of Adapting a Telescope *To a large* Horizontal Dial, *for observing the moment of Time by Day or Night.*

CHAP. I.

The Use and Advantages of this Contrivance.

EVery one the least versed in *Astronomy*, does know of what great Concernment the *Observation* of the exact Moment of Time is therein. Without this no Celestial *Observation* can be performed *Accurately*, and *Astronomy* is like to receive but little advancements. Hereby the *Tables Astronomical* are approved or rejected, and Calculations found true or false. So that whatever advantages we propose to our selves by a Correct *Astronomy*, we shall find our present Indeavour to be helpful towards them. And certainly there are some signal uses expected from it, since so many *Kings*, *Princes*, *States*, and Learned Men in all *Ages*, particularly our late and our present *Soveraign* of *Great-Brittain*, The present *French King*, and formerly some Kings

of *Denmark*, have been at ſuch great expences both of *Time*, *Labour*, and *Charges*, for the advancement thereof. But I ſhall paſs by all other excellent uſes that are expected from an *Accurate Theory* of the motions of the *Heavenly Bodies*, and ſhall only inſiſt on one particular, wherein the *Obſervation* of the exact Moment of *Time* does more immediately tend to the uſe of mankind. We all know how univerſaly the whole World is concern'd in *Navigation* and Commerce, by *Ships* flying before the winds, and floating on the *Seas*; *Nation* converſes with *Nation*, as every man with another by words flying in the *Air*; by this, Civility, Learning, and all Politeneſs is propagated; we are made acquainted with one anothers *Laws*, *Conſtitutions* and *Manners*, we mutually reap the *Fruits* of each others *Countrys*, and are no longer Strangers, but *Fellow-Citizens* of the World. And for all theſe advantages (at leaſt for our more ſecurely reaping theſe benefits) we are in a great meaſure, if not wholly, beholding to *Aſtronomy*. For whoever has but inquired into the firſt Rudiments of that *Science*, does very well know, how far the determination of the *Longitude* of places, and conſequently the advancement of *Geography* and *Navigation* depends thereon. But whether this be attempted by *Eclipſes* of the *Sun*, *Moon*, or *Stars*, or by the *Immerſions* and *Emerſions* of *Jupiter's Satellits* into or from his ſhadow, or by the *Pendulum Clock*, at *Sea*, &c. In all

all these methods the *Observation* of the exact Moment of time is necessary, for otherwise the *Horary* distance of the place of *Observation*, and consequently the distance on the *Æquator*, or *Longitude*, from an assigned place shall be uncertain.

CHAP. II.

Of the Methods used for observing the Exact Moment of Time, and their Inconveniencies and Troubles.

THE common ways used by *Astronomers* for observing the *Time* are, either by *Dials*, or by taking the *Suns Altitude* by day, or by the *Altitude* of fixt *Stars* by night, taken by large and accurate *Instruments*; or by observing the *Altitude* and *Azimuth* of the *Sun* or *Stars*, or lastly by the *transits* of *Sun* or *Stars* cross the *Meridian*, or the coming of some of the *Circum-Polar Stars* in the same *Vertical* with the *Pole-Star*. All these methods have their inconveniences, or at least, are attended with far greater trouble than that which I shall propose.

And first for *Dials*, unless they be very large they will not admit of divisions so minute, as are requisite to the nice determination of the Time, as into minutes, half-minutes, and quarter-minutes. And when they are so large as to admit such, the uncertain shadow that is cast from a long

Gnomon renders them useless for such niceness; for though your *Dial* have on it every quarter-minute, the most accurate eye cannot tell where the shadow determines to a minute. Another grand defect of *Dials* is, that they serve only in the day-time, and that too, when the Sun shines out intensely. So that for the night (which is the chief time of *Astronomical Observation*) *Dials* are perfectly useless.

Perhaps I need say no more to recommend my present contrivance, then to assert that it clearly takes off both these inconveniences. For thereby the larger the *Dial* is, and the more minute the divisions are, the more accurately is the Time observed. A long *Gnomon* in our way hinders not at all, nor is there any uncertainty from a *Penumbra*. And moreover 'tis adapted as well to serve by the Stars at night, as by the Sun in the day, and gives the hour almost by inspection at a Star, as at the Sun. And withal has this advantage, that when the Sun is over-clouded, so as but just to be seen faintly, and casts no shadow at all on a *Dial*; yet in our way, if he be in the least perceivable by the eye, the Time may be exactly told by him.

I cannot say that there are inconveniences in observing the Time, by taking the Sun or Stars *Altitudes* and *Azimuths* by day and night; and yet if we reckon trouble an inconvenience, these methods are not free from it. For, besides the dif-

ficulty and charge of obtaining Inſtruments large and accurate enough for doing theſe, and the dexterity and long practice that is requiſite for rightly managing them: This method is attended by the trouble of Calculating the moſt difficult of oblique ſpherical Triangles, *viz.* that wherein three ſides are given to find an *Angle*; and this, if the obſervation be by the *Altitude* of the Sun in daytime; for by the *Altitudes* of Stars by night, the Calculation is yet more tedious and troubleſome. And if ſo, what a toil muſt it be to ſuppute twenty or thirty of theſe in a night? Beſides, the *Altitudes* of the Sun towards the *meridian* alter ſo ſlowly, that for a good while both before and after noon, 'tis not ſafe to rely upon them. This inconvenience indeed is ſomething remedied at the Stars, where I can chooſe thoſe that are of a proper *Altitude*, and conveniently remote from the *Meridian*, and the obſervation of the *Azimuth* remedies the other uncertainty proceeding from their *vicinity* to the *Meridian.* But, as I ſaid before, the trouble of Calculation attends the obſervation either of *Altitudes* or *Azimuths*; whereas the Inſtrument I propoſe, does the matter with the greateſt certainty, and greateſt eaſe imaginable. There is requiſite therein, beſides a plain and ſimple obſervation, no Calculation by *Triangles*, or any other Operation, ſave only the addition and ſubſtraction of two or three ſmall numbers, to be had in the

Tables

Tables ready Calculated; and that too, only when the obſervation is by the Stars at night.

The methods of obſerving the Time by the *appulſes* of the Sun or fixt Stars to the *Meridian*, or the *Circum-Polars* coming in the ſame *Vertical* with the *Pole*, are plain, ſimple, and eaſy. We have the firſt deſcribed by *Riccioli* in his *Almageſtum Novum*, *Lib.* 5. *Cap.* 15. *Prob.*8. where he ſhews us how to perform it by his *Triangulum Filare*. The latter way is deſcribed by Sir *Jonas Moore* in his *Compendium Mathematicum*, *p.* 118. and more fully in the Royal Almanacks for the years 1676, 1677, 1678. And I have by me Tables laboriouſly and carefully Calculated by my eſteemed Friend *Henry Osburn* Eſq; an excellent Aſtronomer and Mathematician for *Dublin* and other *Latitudes* in *Ireland* to years lately paſt, and to come, which are to be uſed in this way. But, though both theſe ways (as I ſaid before) are very plain and eaſy, yet they ſerve rather to rectifie Watches and other Time-keepers, then to ſhew the Time themſelves throughout the whole courſe of an obſervation; as, ſuppoſe it were an Eclipſe of the Moon, perhaps when a ſpot either immerges or emerges into or from the ſhadow, there is not at that very inſtant, and perhaps will not be for many minutes after, a Star in the *Meridian*, or under the *Pole-ſtar*, to tell me the moment of that time.

But what I propoſe does as conſtantly (and not

by

by fits) ſhew, and follow the time, if duly managed, as the Hand of a well-going *Pendulum-Watch* indicates the hour; that is to ſay, it tells you the preſent minute, and quarter of a minute, whenever you are pleaſed to look, as well as any other, paſt, or to come.

CHAP. III.

A Deſcription of the Inſtrument.

THe contrivance of this Inſtrument conſiſts in making a very large *Horizontal Dial*, adapted to your proper *Latitude*, and capable of receiving diviſions into minutes, and parts of a minute, fitted with a large, ſtrong, and double *Gnomon*; I call that a double *Gnomon* that caſts the morning-ſhadow from its Weſtern-edge, and the afternoon-ſhadow from its Eaſtern-edge, and the noon-ſhadow by its thickneſs. This *Dial* is to be furniſhed with two pair of Sights or Rulers; one to ſerve in the morning, or for Stars on the Eaſtern-ſide of the *Meridian*, t'other to ſerve in the afternoon, or for Stars on the Weſtern-ſide of the *Meridian*. Each of theſe pair conſiſts of two movable Rulers, one I will call the *Horizontal-Ruler*, t'other the *Gnomonick-Ruler*, or *Stile-Ruler*. Theſe two Rulers are to be ſo adapted, that their two edges that are next the

the *Gnomon*, may be perpetually in the ſame plane with each other, and at the time of obſervation, that they both may be in the ſame plane with their correſpondent edge of the *Gnomon*. On the *Stile-Ruler* are fixt Teleſcopick Sights, and the croſs hairs in their due place. But all this will be made plainer by the firſt Figure, in which I ſhall repreſent that Inſtrument which by my directions was made in *London* in the Summer 1685 by *Richard Whitehead* Math. Inſt. Maker, who took the directions from my ſelf, but made the Inſtrument in my abſence.

The firſt Figure repreſents the Inſtrument in Perſpective, having one pair of its Rulers in a poſture of obſervation; t'other pair lying careleſly on the plane of the *Dial*. 'Tis a large Octogonal Braſs-plate, clear'd in the middle, except only the croſs-bars *zzz* of the ſame piece with the Plate, left for ſtrengthning the Inſtrument, and receiving the Stile, the Plate is of a moderate thickneſs about $\frac{15}{100}$ of an inch, the Diameter of the largeſt circle it receives is 18 inches, 'tis ſupported from the plane on which it ſtands about three quarters of an inch by three braſs-feet 2. 2. 2. the bredth of the limb for receiving the Figures and Diviſions, is $2\frac{1}{2}$ inches. The thickneſs or bredth of the face of the Stile *malb* is $\frac{7}{10}$ of an inch. The Diviſions actually expreſſed upon it are hours, half hours, quarters, five minutes, minutes, and half minutes, and

and one may easily judge of the third part of an half minute, that is, 10 seconds. Down along the face of the Stile (some perhaps will call it the back of the Cock) there runs a deep Groove, to receive the screw *m. l.* which screw, by turning the handle *n*, raises and lets down the Nut *op*, on which the Stile-Ruler *ef* rests, and is thereby raised and let down, as the Sun or Star requires. This Nut *op* is furnish'd with a Return'd Fork, meerly to keep the Stile-Ruler from an accidental fall, if any thing should chance to move it rudely. But I shall describe this Nut *o.p.* presently by it self. The screw *m. l.* is fixt both at top *m* and bottom *l*, so that it only is to be turn'd round by the handle *n.* the Stile is fixt most strongly by the screws, *q. r.* I come next to describe the Rulers, and first for the *Horizontal* Ruler *c d*, this turns most truly upon the Center of the hour-lines and divisions at *k*, and has so much of the root of the Stile clear'd off, as its thickness requires to permit its motion freely; the line *c d* of this Ruler crosses the Center most exactly, and the edge *c d* is neatly cypher'd off (as the Workmen call it.) Wherefore the right line *a b* of the Stile, and the line of the under-edge of the *Horizontal Ruler c d*, meeting, and crossing perpetually in the same point *k*, they shall be always in the same plain, (by *Prop.* 2. *Eucl.* 11. Book.)

To the other end of this *Horizontal Ruler* there

is adapted the Stile-Ruler *e f*, which by means of the joynt *v x y* (which I ſhall deſcribe by it ſelf) obeys two ſeveral motions, *viz.* one upwards and downwards, as govern'd by the Nut and ſcrew on the Stile; and t'other Eaſtward and Weſtward, according to the *Azimuth*, or as it follows the *Horizontal* Ruler. And in theſe two motions, 'tis ſo contrived, that the line *c d* and *e f* may perpetually croſs each other in one and the ſame Center at *y*. Hence it comes to paſs, that the right line *c d*, and the right line *e f*, are always in the ſame plain. Wherefore laying the line *e f* to the edge of the Stile, the three lines *a b*, *c d*, *e f*, are in the ſame plain; and conſequently directing the line *e f* to the Center of the Sun, the edge of the *Gnomon*, and the edges *c d* and *e f* of the Rulers are in the plain of the ſhadow; and therefore the Ruler *c d* cuts the diviſion on the limb of the Dial-Plate, where the ſhadow would cut it.

To the Stile-Ruler are fixt, the Eye-glaſs at *h*, the Ring that carries the croſs hairs at *g*, and the Object-glaſs at *i*; The manner of adjuſting all which, I ſhall ſhew preſently.

But I muſt not forget to mention the Artificer, whoſe hands were imploy'd in this Inſtrument, Mr. *Richard Whitehead* living in *Gunpowder-Alley* in *Shoo-Lane*, by *Fleetſtreet*, *London*, a moſt exact and careful Workman, of whoſe skill and curioſity in

making

making Mathematical Instruments, I have more than this one instance; And I dare venture to recommend any Gentleman to him, as a most exact performer.

CHAP. IV.

Of the Stile-Nut, and Ruler-Joynt.

IN the foregoing Chapter I have promised a particular description of some of the forementioned parts belonging to this contrivance; and first of the Nut *op* (*Fig.* 1.) This I have represented by it self in *Fig.* 2. *s s* is the Stile-screw passing through the Nut *n*, which is lined with a female-screw; this Nut slides in the Groove along the face of the *Gnomon*, so that the whole thickness of the screw lies under the said face. *p p* are two arms that clasp the Stile to make the motion of this Nut more even and steady. *f a b* is the Return'd Fork to keep the Rulers, when they are supported on this Nut, from any accidental fall, and is very useful when the *Horizontal* Ruler is removed far from the *Meridian*. And least at any time, either of the Returns *a b*, may stand in the way of either of the Rulers motions, the parts *a b* are movable at *a* by a riveted joynt, and may be turn'd clearly downward out

of the way, as at *a c*, *a c*. At *a* there may be fixt a ſmall gentle ſpring, that may lightly bear the edge of the Ruler conſtantly to the edge of the Stile; but this contrivance is not on my Inſtrument, though it may be eaſily added.

The ſeveral parts of the Ruler-joynt (which indeed is the moſt curious piece of Mechanicks about the whole Inſtrument, and on which the whole affair does chiefly depend) are repreſented all apart in Figures by themſelves. *Fig.* 3. ſhews the outward end of the *Horizontal* Ruler, *a a a* are the holes that admit the ſcrews which faſten it to the other parts of the joynt, particularly to the ſocket ſhewn in *Fig.* 5, 6, 7, 8. at *a a a*. *Fig.* 4. ſhews the other end of the *Horizontal* Ruler, where it turns on the Pin in the Center of the Dial at the root of the Stile (at *k Fig.* 1.)

Fig. 5. expreſſes the appearance of the joynt, when diſcover'd of *Fig.* 3., *i h i* is a perfect hinge, the Center of whoſe motion is in the line *f h*, *i i i* that part of the hinge belonging to the Ruler, *h h h* that part belonging to the Tumbler or Nut expreſſed in *Fig.* 7. *h h h*. *a a a* the ſocket wherein the Tumbler *h h h* moves round and truly on the Center at middle *h*, which alſo is in the Center of the hinges motion. This ſocket *a a a* is repreſented in *Fig.* 8. *b b* are the ſcrew-holes for the Ring and Snout of the Eye-glaſs.

Fig 6 ſhews the under-ſide of *Fig.* 5. where the

ſame parts are marked with the ſame letters; *c* is the round Pin of the ſame piece with the Nut *hhh*: This is more plain in *Fig.* 7, this Pin turns truly in the hole of the ſocket *c* in *Fig.* 8. whilſt the Nut *h h h* of *Fig.* 7. reſts and turns on the bottom of the ſaid ſocket *h h h Fig.* 8. This Nut is kept cloſe in the ſocket, and there made to move ſteadily and truly by the Pin *e* and ſpringing Plate *d Fig.* 6. and 9. which Pin *e* paſſes over the Plate *d* through the Pin of the Nut *c*.

CHAP. V.

Of the Teleſcopick Sights, and their true Adjuſting.

FOr the true adjuſting of the *Teleſcopick* Sights *h g i* (*Fig.* 1.) to the Stile-Ruler *e f*, there are three things requiſite. But firſt I muſt advertiſe, that the Stile-Ruler *e f* ought to be ſo ſtrengthned, that as it reſts on the Nut *o p*, it may not at all bend, but that the line *e f* may be one right line as nigh as poſſible. But in this particular the greateſt niceneſs is not requiſite, for if the Ruler chance a little to deviate from its exact ſtraightneſs, I ſhall ſhew a way of rectifying the error by the croſs-hairs or *Menſurator*.

The firſt thing requiſite to the placing of the *Teleſcopick* Sights is, that the ring *g*, that carries the

the croſs-hairs or other *Menſurator*, be at a due and exact diſtance from the Object-glaſs *i.* This diſtance is to be exactly the total length of the Object-glaſs; but that we may get this total length more accurately than by any admeaſurement, the Eye-glaſs and Object-glaſs being adapted together, and placing the *Menſurator* in the ring *g* between the Object-glaſs and Eye-glaſs at the diſtance of the *Focus* of the ſaid Eye-glaſs, let us look at ſome object diſtant 4 or 5 miles, and moving your eye before the Eye-glaſs, obſerve whether the *Menſurator* ſeems to move upon the ſaid object; for if it do, then the *Menſurator* is not at its exact diſtance from the Object-glaſs, but the Object-glaſs is to be removed farther or nigher, till the eye looking at ſuch a diſtant object, and moving before the Eye-glaſs, perceives the *Menſurator* as it were fixt and immovable on the object. If in raiſing the eye, the object ſeem to fall down on the *Menſurator*, or in depreſſing the eye, the object ſeem to riſe on the *Menſurator*, then is the Object-glaſs too nigh the *Menſurator*. But if in raiſing the eye, the object ſeem to riſe on the *Menſurator*; or in depreſſing the eye, the object ſeem to fall on the *Menſurator*, then is the Object-glaſs too far from the *Menſurator*. All which will be evident from the 10 *Fig.* wherein let *A B* be a diſtant object, whoſe middle point *C* is projected by the Object-glaſs *D* at *k*, let *m n* 1 be the *Menſurator*

ſurator to which the Object-glaſs is too nigh, and *m n* 2 the *Menſurator* from which the Object-glaſs is too far, *e*, *f*, *g*, the eye placed at three different poſtures; in caſe of the firſt *menſurator*, if the eye riſe from *e* to *f* it perceives the point *k* depreſſed from 1 to *h*; or if the eye fall from *e* to *g*, it perceives the point *k* raiſed from 1 to *l*; and here the *menſurator* is too nigh the Object-glaſs. But in caſe of the ſecond *Menſurator*, if the eye riſe from *e* to *f*, the point *k* ſeems to riſe on the *Menſurator* from 2 to *r*; or if the eye fall from *e* to *g*, it perceives the point *k* fallen from 2 to *s*, and in this caſe the *Menſurator* is too diſtant from the Object-glaſs; but if the *menſurator* be exactly in the *Focus* at *k*, let the eye riſe or fall, the *menſurator* ſeems fixt and ſteddy upon the object. And this is the firſt thing requiſite to the adjuſting of theſe Sights.

This Affair is uſually ſo well adjuſted by the Workmen, and when once adjuſted, is never alterable, that I need ſhew no way of providing for it. But in ſhort, it may eaſily be provided for, by making the holes for the ſcrews, that fixt the Object-glaſs-ring to the Stile-Ruler, long ſlits, ſo as to ſlip forwards and backwards on the necks of the ſcrews; and when the Object-glaſs is at its right poſture, the ſcrew-heads may pinch and fix the Ring ſteddily.

The next requiſite is, that the line of *Collimation* from the *menſurator* through the Object-glaſs, and

ſo

so to the object, run parallel to the line *ef* of the Stile-Ruler. This *Parallelism* consists in two manner of ways, first, that the *mensurator* be neither more to the right or left-hand than requisite; or secondly, that it be neither higher or lower than it ought. The first error makes the *Azimuths* be shewn false, and the second error makes the *Altitudes* be shewn false: but an *Horizontal* Dial tells the time by both *Altitude* and *Azimuth*; therefore both these are to be taken care of.

And first for the Fabrick of the Ring *g*, that carries the *mensurator*; this is so to be order'd, that first the Ring may be moved more to the right or left-hand, and there to be fixt; and secondly, that the *mensurator* may be raised or depressed according as is requisite, and there fixt. The first is obtain'd by making the holes for the screws, whereby this Ring *g* is fixt to the Stile-Ruler, long slits, so that they may slip on the necks of the screws before the Eye-glass, and when they are in their right posture, may be pinched close by the screw-heads, and there fixt. Thus therefore we give the *mensurator* a motion to the right or left-hand, by which 'tis brought to shew the *Azimuth* right, as I shall declare presently. Next, that the *mensurator* may be raised or depressed, instead of cross-hairs in the Ring *g*, let there be placed therein a very strong Steel-needle, that may end in a most fine slender point: this needle

is

is to be a ſcrew almoſt its whole length nigh to its ſmaller end, and to be ſcrew'd through the top of the Ring *g*, ſo that its ſmaller end may paſs through the center of the Ring; by ſcrewing or unſcrewing of this Needle, we depreſs or raiſe its fine point in the Ring. And thus much for the contrivance or Fabrick of the Ring.

I come now to ſhew the way of managing theſe two motions in the *Menſurator*, ſo as to bring it to its true poſture, and there fix it. And firſt for rectifying the *Menſurator* ſo as to ſhew the true *Azimuth*. There are two manner of ways for doing this. The firſt is more troubleſome and tedious, but being moſt univerſal to the fixing of *Teleſcopick Sights* on all *Rulers*, I ſhall here deſcribe it. In *Fig.* 11. let *ABCD* repreſent a *Ruler*, whoſe edge or ſide *AC* is exactly parallel to its ſide *BD*. To make a *Ruler* thus parallel, is not difficult to a good Artificer; but I ſhall ſhew how to try whether theſe ſides are parallel or not. *E* is the Object-glaſs, *F* the *Menſurator*, *G* the Eye-glaſs. On a plain Board ſtrike two round Braſs-pins, as ſuppoſe at *H* and *I*, to theſe apply the ſide of the *Ruler BD*, ſo as it may reſt againſt the pins, which are therefore not clearly buried into the Board, but ſtand out about $\frac{1}{10}$ of an inch: then look through the Glaſſes, and obſerve where the *menſurator* falls on an object diſtant a mile or two. Then remove the *Ruler*, and apply its other

fide *AC* to the other fide of the pins *HI*, and obferve whether the *menfurator* falls on the fame point of the object as before. If it do fo, then are the fides of the *Ruler AC*, *BD* parallel; if not, then the fides are not parallel. The reafon that fo remote an object muft be chofen, is, that the bredth of the *Ruler* may fubfend an inconfiderable *Angle* in a circle, whofe *Radius* is the diftance of the object. Having found the fides of the *Ruler* to be parallel, the next thing is, to make the line of *Sight*, or line of *Collimation LK* parallel to thefe fides, for therein confifts the firft rectification of our *Stile-Ruler*. The method of doing this is much the fame with what immediately precedes, but requires another difpofition of our pins; for now we are to raife our plain Board fo as to ftand edge-wife, nigh perpendicular to the *Horizon*, and the pins muft ftand an inch or more out from the Board, almoft parallel to the *Horizon*; then refting the under-fide of the *Ruler* on the pins, and applying its edge to the plain Board, obferve the point of a remote object whereon the *menfurator* falls; in this pofture the Glaffes ftand uppermoft, or on the upper-fide of the *Ruler*, and over-look the pins. Then remove the *Ruler*, and hang the other fide thereof on the pins, that now the Glaffes may be on the underfide the *Ruler*, or under-look the pins, and refting the edge againft the plain Board, obferve whether

ther the *mensurator* fall on the same point as before; if it do, then is the line of *Collimation LK* parallel to the sides *AC*, *BD*; if it do not, but falls to the right-hand apparently of the said object, then is the *mensurator* to be removed (by means of the screws and slits in its Ring) to the left-hand: the contrary requiring the contrary. And thus by frequent repetitions and trials we at last bring all to rights. The most convenient Board or Table for this Operation, is a Surveyors Plain-table; for these being usually made true, and readily and steddily obeying all motions and postures, and are easily fixt thereat; they are to be chosen before any other. Note also that the pins to be used with this or such like Table, are to be strong brass-wire, which having its roundness from its drawing, is sure to have its sides parallel. By this method, the line of sight of any *Cylindrical* or square *Telescope* may be made to run parallel to its sides, for finding the Declination of the *Magnet* according to the methods lately proposed by *Monsieur Hautefeville*, and Mnsr. *Sturmius*, in the Journal *des Scavans* 23. *Aug.* 1683. and in the *Acta Lipsiæ*, *An.* 1684. *mens. Decemb.* and for want of this method, what Mnsr. *Sturmius* says in the foresaid *Act. Lips.* *pag.* 579. is very defective. For thus he, *Sola tubi locatio ut axis visionis per medias lentes excurrens meridianæ lineæ exacte respondeat difficultatis quippiam habere videbatur, verum & huic infirmitati præsens, uti*

 credo,

credo, inventum est remedium, &c. And the remedy he tell us is, that the *Tube* be made a parallelipiped of Wood or Brass; for then, says he, applying the side of your *Tube* to the *meridian line*, the *Axis* of *vision* will be parallel to the said *meridian line*. But I must crave leave to deny this, unless first it be rectified, so that this *Axis* runs parallel to the side of the *Tube*, which he was not aware of: and this is to be done by the method I have just now proposed, which serves likewise in many other Occasions, Experiments and Practises, wherein a *Ruler* with *Telescopick Sights* is requisite.

The second method for effecting this said rectification, is more easily applicable to our *Dial*, and withal is sufficiently accurate, as doing the business to 10″ or 15″ seconds of time at utmost, and by a careful and curious eye, may do it to half that or less. Place the *Dial* so before the Sun, that as nigh as possibly the eye can judge, the *Gnomon* may be equally enlightned on both sides, that is, that the shadow of the Stile may fall exactly on 12 a Clock, or the *meridian line* of the *Dial*. This perhaps will be said by some to be no fair proceeding, because in this we cannot tell where the shadow does exactly determine, and that this being one of the inconveniences our *Dial* pretends to remedy, if we *rectify* our *Dial* by supposing we can determine *that*; & if afterwards we determine

that

that by ſuppoſing our *Dial rectified*, it will ſeem a circle in *Argumentation*,but yet I ſay,they that will try it, will find it otherwiſe; for I can place the *Dial* ſo, that the ſhadow from the thickneſs of the Stile, or at leaſt the *Penumbra* from both the Stiles edges, ſhall ſo equally fall upon the 12 a Clock-lines, that 10" ſeconds of time, or leſs, ſhall ſenſibly alter the equality. And 'tis not the ſame caſe in telling when this ſhadow comes to an equality on both the 12 a Clock-lines, as in telling when the ſhadow of one of the ſingle edges of the *Gnomon* comes to any of the other hour-lines. For in the firſt caſe I am only to judge by compariſon, *when* the ſhadow is come as much to one of the 12 a Clock-lines as to th'other; but in the latter caſe I am to judge poſitively without compariſon. Wherefore having the *Dial* in this poſture, bring the *Horizontal* and *Stile-Rulers* juſt to 12 a Clock on the *Dial-Plate*, and obſerve whether your *Menſurator* divide the Sun equally into an *Eaſtern* and *Weſtern* half; if it do ſo, then is your *Menſurator* right; if not, the *menſurator* is to be moved ſomething to the right or left hand, as is requiſite, till at laſt by frequent repetitions and tryals we obtain our deſire. And thus much ſhall ſuffice concerning the rectification of the *menſurator* to the right or lef thand, ſo as to ſhew the *Azimuths* truly. I ſhall only take notice, that when one pair of the *Rulers* is rectified, the other

pair

pair is easily rectified by them; for bring the rectified pair to the 12 a Clock-line on the *Dial*, and move the whole body of the *Dial*, till you get the center of the Sun, or any Star on the *mensurator*, then immediately bring the unrectified pair of *Rulers* to the 12 a Clock-line on their side, and if the Sun or Star be not exactly on the *mensurator* on this pair, the *Mensurator* is false, and must be rectified, as is requisite: but this being plain to the meanest capacity versed in these matters, I shall insist no longer thereon.

But I proceed to the other Rectification of the *Mensurator* for rightly telling the *Altitudes*, as I have said before. And tho there be not so very great exactness required herein, especially in telling the time by the Sun or Stars when nigh the *Meridian*; yet a gross error herein must not be allow'd. This likewise is to be performed much after the same method with the former Rectifications, for 'tis but contriving some way for inverting the *Ruler*, so that its errors of this kind may be perceived, as by our former Inversions we discovered the errors of another kind. But to make this a little more plain, this error consists in the line of Sight not running parallel with the under-side of the *Ruler*; wherefore if we have (suppose) a *Deal-board* whose two faces are exactly parallel, and this *Board* be raised and fixt

so

so as to lye steddily along one of its edges, and on each face of the Board there were a ledge to support the Ruler; and the Ruler be applyed by its under-side to one face of the Board, and the object marked out by the *Mensurator*, diligently observed; and then the Ruler applyed by the same under-side to the other face of the Board: If the same object be now cut as formerly, ly, all is right; if not, the *Mensurator* (being such as I have formerly described) must be screw'd or unscrew'd, so that the fine point thereof may be lower or higher in the Ring, according as is requisite.

Another more easy way of discovering and rectifying this Error to sufficient accuracy, is thus: After you have by the former methods brought the *Mensurator*, and thereby the *Ruler*, to shew the true *Azimuth*; observe the time by the *Dial* when the Sun is very far removed from the *Meridian*, as early in the morning; and at the same time observe by a good *Pendulum* Clock the hour, minute, and second; and note the difference between the *Dial* and Clock. Proceed thus to make an observation every quarter of an hour through the whole morning, still noting the differences: And because we may well suppose that a good *Pendulum* Clock in so short a course of time goes equally, these differences should be always equal; but if they are unequal, then the *Mensurator* shews

the

the *Altitudes* falſely. As for inſtance, ſuppoſe I find that approaching towards Noon theſe differences decreaſe, then does the *Menſurator* on the *Teleſcopick Ruler* ſhew the *Altitudes* too little, and therefore muſt be order'd ſo as to ſhew them more: if I find them increaſe, the contrary is to be done. The reaſon of this is plain, for an *Horizontal Dial* ſhews the time as well by the *Altitudes* as *Azimuths*; but as the time approaches towards Noon, the *Altitudes* are leſs concern'd in the matter than the *Azimuths*; and ſo leſs and leſs, till juſt at Noon the time is not at all ſhewn by the *Altitude*, but ſolely by the *Azimuth*. And conſequently, if there be any error in the time ariſing from a falſe *Altitude*, it will appear by comparing two times or more together; ſome, wherein the *Altitudes* are much concern'd, and others, wherein the *Altitudes* are little or not at all concern'd; but ſuch times are, early in the morning, and towards noon.

CHAP. VI.

The Way of Setting this Dial.

TO the true Setting of this *Dial*, there are two things requiſite; Firſt, that the plain of the *Dial* be in an exact *Horizontal* poſture, this is

is easily obtain'd by accurate levels, which are so common, that I shall mention nothing further hereof. The second requisite is, that the *meridian* or 12 a Clock-line of the *Dial* be in an exact *meridian* line. This indeed is one of the chief particulars that we are to take care of, for thereon depends the accuracy of the whole. But that we may not over-turn or neglect the whole affair for the difficulty of this one particular, I shall shew that this is no such insuperable hardship as may be imagin'd. Let us therefore consider, that what is here alledged as a difficulty in this *Dial*, may as well be made against the large *Azimuthal Quadrants* used by *Astronomers*, and their observations of *meridional Altitudes*, and *transits* through the *Meridian*; *Ricciolis Triangulum Filare* described *Almag. Nov. Lib.* 5. *Cap.* 15. *Probl.* 8. and all Enquiries after the *Declination* of the *Magnet* are to no purpose; for these wholly proceed on the discovery of an exact *meridian line*. And indeed there are ways sufficiently accurate described by several for finding the true *meridian*. Amongst others, *Hevelius* in the first Part of his *Machina Cælestis*, *Chap.* 16. has many contrivances: And I shall presently set down an Instrument and way of my own for doing it, inferior, I think, to none. But let us a little consider, how much a *meridian* line must be erronious, to make a true *Dial* apply'd to it to err a minute in time; and this in our *latitude* of *Dublin*

will be 12' minutes of a *Quadrant* to make the *Dial* err a minute in time about noon; and for ſo much error in the *meridian* line the *Dial* ſhall err leſs than a minute in time about 5 and 6 a Clock, as is manifeſt to thoſe that underſtand calculating hour diſtances for an *Horizontal* plain. Now 'tis a very rude way indeed that will not take a *meridian* line more accurately than to half or quarter 12 minutes error.

But laſt of all, (clearly to take off this difficulty,) if it be allowed that there is any moſt accurate way of telling the time of day or night, as by the *Altitude* of the Sun or Stars taken by large and curious Inſtruments, and Calculating thereby; I ſay, by ſuch a way as this I will ſet my *Dial*, and then ſurely it will be granted to be in a true *Meridian*. And perhaps this very hint may ſhew as accurate a way as any in the World for finding a *meridian* line; for the 12 a Clock line of a large and true *Dial* that is Set by ſuch an accurate obſervation muſt needs lye in a true *meridian* line.

But I am mindful of my promiſe, *Viz.*

CHAP.

CHAP. VII.

For Finding a Meridian Line.

THis is perform'd by means of the Instrument represented *Fig.* 12. *ABC* is a *Triangle*. (That which I have made is of Wood, but a good Mathematical-Instrument-maker would make one much better of Brass.) *AB* I call the *Perpendicular* side, *BC* the *Horizontal* side; in the end of the *Horizontal* side at *E* there is a screw, and from the said *Horizontal* side there strikes out a short arm *D*, in which also there is a screw; this arm *D* keeps the Instrument steddy from tottering. By means of these two screws at *D* and *E*, the side *AB* is brought to its exact perpendicularity; but especially by means of the screw *D*, the edge *x z* of the side *AB* is brought to stand exactly in the same *Vertical* plain with the edge *m n* of the side *BC*, and this by help of a Plum-line. *F* is a plate of Brass, having in it a center-hole in the line *m*, *n* continued. *G* is a round, slender, but strong Brass-pin arising perpendicularly from the face *m n*. 1,2,3,4,5, &c. are round Brass-pins that rise and stick out from the face *x z*, at what distances we please. This Instrument being placed truly on an exquisite *Horizontal* plain,

 so

ſo that its end *E* may ſomething over-ſtretch the plain, and turning ſteddily on a pin in the center-hole F, lay a *Ruler* adapted with *Teleſcopick Sights* over the pin *G*, and any of the other 1, 2, 3, *&c.* as is found moſt convenient and agreeable to the *Altitude* of the Sun or Stars you obſerve by, at convenient times both before and after Noon. 'Tis therefore requiſite that in the under-side of your *Teleſcopick Ruler* towards the end next the eye, there be fixt a pin, that reſting on the pin *G* may keep the *Ruler* from ſlipping down in this declining poſture. Let us then ſuppoſe that about 9 a Clock in the morning on the Summer *Solſtice*, the *Teleſcopick Ruler* reſting on the pin *G*, and the third pin in the perpendicular side takes the Suns *Altitude* exaƈtly, then on the *Horizontal* plain draw a line along the face *m, n.* Again, let us ſuppoſe that the *Ruler* removed upwards to the fourth pin, and there reſting, takes the Suns *Altitude* the ſame morning about half an hour after 9; then by the face *m n* let us draw another line on the *Horizontal* plain, and ſo let us proceed to elevate the *Ruler* on other pins, to make obſervations at 10, at half an hour after 10 the ſame morning, ſtill drawing lines on the *Horizontal* plain at each obſervation.

Then again in the afternoon let us deſcend by the ſame ſteps or pins, by which we riſe in the morning, diligently obſerving when the Sun

comes

comes to the correſponding *Altitudes*, and drawing lines as before. Here we ſhall have three or four obſervations made in the morning, and as many in the afternoon. Then *biſecting* theſe *Angles* from the point *F*, if all their *biſections* are coincident in the ſame right line, we are ſure that line is a true *meridian* line.

What is here ſaid of the Sun, and of obſerving by it at the Summer *Solſtice*, may be accommodated to the taking a *meridian* line at any time of the year by ſome fixt Stars, that being removed about 2 or 3 hours from the *Meridian*, have *Altitude* convenient; though in chooſing of a great *Altitude* there is no great nicety; for if *Refraction* do interpoſe in the morning-obſervation, it interpoſes as much in the afternoon-obſervation; ſo that 'tis as if it did not interpoſe at all. And here we have a way of finding a *Meridian* line by the Stars at night, which is of no ſmall advantage, they being not ſubject to ſudden alteration of their Declination, and conſequently this method may be practiſed at all times of the year.

And indeed if we are careful to have all things exact, *viz.* an exact *Horizontal* plain, the face *x z* in an exact *Vertical* with the face *m n*, the *Teleſcopick Ruler* and its Sights exactly adjuſted by the methods in the foregoing 5*th* Chapt. and be very diligent and accurate in obſerving the true *Altitudes*, this method of finding a *meridian line* will

appear

appear inferior to none that has yet been proposed.

Such a plain *Telescopick Ruler* as is expressed in the 11*th.* Figure, of a convenient length, is sufficient in this practice.

CHAP. VIII.

The Manner of observing the Time, and exactly determining it by the Sun or Stars.

ALL things being rightly adjusted, and the *Dial* placed in an exact level or *Horizontal* posture, and by a true *meridian* line, look at the Sun through the *Telescopick* or *Stile-Ruler*, and bring the *Mensurator* upon the Suns center, then shall the *Horizontal Ruler* cut the hour, minute, and part of a minute most exactly. But for Setting, or finding the error of a Clock, the best way is to bring the *Horizontal Ruler* to some full Division, as, to some compleat minute; and by rightly managing the *Stile-screw* and *Nut*, and *Stile-Ruler*, observe when the center of the Sun and *Mensurator* come together, for that is the exact time to which you placed the *Horizontal Ruler*. And indeed through the *Telescopick Sights* we shall perceive the motion of the Sun so very quick, that we may determine its being on and off the *mensurator* to 2 beats of a second

second *Pendulum*. So that if it be granted me that I can bring and settle the *Horizontal-Ruler* to a full division exactly, and not to err in placing it thereat over 3, 5, or 7 seconds, I can determine the time of day or night to 3, 5, or 7 seconds. But if this great exactness will not be allow'd me, I say it is not on the account of any fault in the *Theory* of this contrivance, which I dare assert to be most accurate in it self, but on the account of the workmanship or deficiency of some of its parts. And that strikes not at the Inventer; let those that use them, and adjust them, look to their truness in all particulars.

The way of using this *Dial* at the Stars by night is much the same, only for these there are requisite the Tables, at the end of this Book, of the Sun and Stars temporary *Right Ascensions*. In looking at, or observing a Star through the *Telescopick Ruler*, the *Horizontal Ruler* cuts the said Stars *horary* distance from the *Meridian*, but then the hours are to be counted by the smaller Figures on the in-side of the limb. Thus, suppose I observe a Star, and find the *Horizontal Ruler* cut the ten a Clock line to which the great Figure of *X* is affixt, the *horary* distance of that Star from the *Meridian* is 22 hours, that is, twenty two hours are elapsed since that Star was last in our *meridian*, though really the Star be but 2 hours to the East of our *meridian*. This premised, the great Rule

for

for telling the time by the Stars is this; *To the Stars horary diſtance from the meridian, add the Stars temporary Right Aſcenſion, and from the Sum ſubſtract the Suns Right Aſcenſion, the remainder (rejecting 24 hours if need be) gives the hour, minute, &c. of the night.*

I ſhall declare this by an Example. *Anno* 1686. *April* the 5*th*. between 9 and 10 a Clock at night I deſire to know the exact time. I obſerve by *Spica Virginis*, and find (ſuppoſe) its horary diſtance from the *meridian* 22 *h*. 03′ 15″. The temporary *Right Aſcenſion* of that Star for that year is, 13 *h*. 08′. 46″, this added to the foreſaid *horary* diſtance, the ſum is 35 *h*. 12′. 01″. At the ſame time the Suns place is ♈. 26° 13′ 59″. Therefore its *Right Aſcenſion* in time by the following Tables, is 1 *h*. 37′. 17″. this ſubſtracted from the foreſaid ſum (and rejecting 24 hours) leaves 9 *h*. 34′ 44″. the exact time of night. The reaſon and demonſtration of this method depends on Aſtronomical Principles, which at preſent I muſt not undertake to illuſtrate, but are obvious enough to thoſe that are verſed in that Science, and will be very plain to thoſe that conſider the way of Calculating the hour of the night by the *Altitude* of a Star given, according to the moſt Learned and Ingenious *Pere Tacquets* Illuſtration thereof in his Aſtronomy, *Lib*. 5. *Cap*. 4. *Num*. 45.

And though there are other ways of ordering the foregoing *Data*, for getting the hour of the night,

night, yet what I propose is as plain and easy as any, and less embarras to the mind.

But here I must not omit one particular, and that is, that by our present contrivance, the *Right Ascension*, or place in the *Æquator* of any Star, is most easily and accurately obtained. How difficult and troublesome 'tis to obtain the *Right Ascension* of Stars, is known to Astronomers, and will appear to those that consult the forementioned *Tacquet Astronom. Lib.* 5. *Cap.* 1. *num.* 4, 5. but by this Instrument, and a truly rectify'd *Pendulum* Clock, the business is easily perform'd: For, from the sum of the Suns *Right Ascension*, and hour of the night (known by the Clock) substract the Stars hour on the *Dial*, the remainder is the Stars *Right Ascension* in time, which converted into degrees and minutes, shews the *Æquatorian* distance of the Star from the first point of ♈, or its *Right Ascension.*

CHAP. IX.

Of the Tables of the Suns and Stars Temporary Right Ascensions.

THE Table of the Stars *Right Ascensions* in time is plain enough of it self. 'Tis computed to the year 1686, and will serve for ten years to come without the error of half a minute.

nute. 'Tis according to *Riccioli*'s Catalogue of fixt Stars in his *Astronomia Reformata*. It consists of 5 Columns, the first contains the *Magnitudes*, the second shews the *Greek Letters* by which each *Star* is marked in *Bayers Uranometria* Printed at *Ausburg*, 1603. The third has the numbers by which each *Star* is noted in *Ticho*'s Catalogue, which is followed by most Authors, but is to be found particularly in *Tichonis Brahe Astronomiæ Instauratæ Progymnasmata*, *pag.* 258. and at the end of the *Rudolphine Tables* published by *Kepler*. The fourth Column contains the *Stars* names, as they are in *Bayer*'s *Uranometria*; and also after each name we express the common name in *English*, and as they are to be found on our common Globes. And here we must not wonder to find that called *Right* or *Left* in the *Latin* names of *Bayer*, that is called *Left* or *Right* in the *English* common names; as for instance, *Herculis Humerus Dexter*, is in *English*, the *left shoulder of Hercules*. For the reason of this will appear plain to those that consider the Constellations of *Bayer*, and the common Constellations on our *Globes*. And I thought it not amiss to take all this care, and express all these marks for the sake of those that are not so well versed in the appearance of the Firmament, that they may the readier find out, and not so easily mistake any of the forementioned *Stars*. The fifth and last Column expresses

ſes the *Right Aſcenſion* in time of each *Star* to the preſent year 1686.

The Tables of the Suns *Right Aſcenſion* in time require the Suns place to be had from ſome good Tables or *Ephemerides.* They conſiſt of four Columns, the firſt contains every degree and 10 minutes of the Suns place, the ſecond contains the hours appropriated to the ſigns between the *Vernal* and *Autumnal Equinox*, the third ſhews the hours appropriated to the ſigns between the *Autumnal* and *Vernal Equinox*; and the fourth and laſt ſhews the parts of an hour, that is, minutes and ſeconds, that are common to the oppoſite ſigns. By the ſide of each diviſion are expreſſed the differences between every 10 minutes of the Suns place, for more ready making proportion. For Example, ſuppoſe the Suns place were ♈ 25°. 10′ I find its *Right Aſcenſion* 1 *h.* 33′ 15″. But if his place were ♎ 25°. 10′. the *Right Aſcenſion* would be 13 *h.* 33′. 15″. Where we ſee 33′. 15″. common to both places. But ſuppoſe I find by a good *Ephemeris* the Suns place about my required time to be ♈ 25°. 15′ then by making proportion I find by the Tables the *Right Aſcenſion* to be 1 *h.* 33′. 34″. For I ſay if 10′ (the common difference of the minutes) give 38″, what ſhall 5′ (the difference between 10′ and 15′) give, and it will be 19″, which added to 1 *h.* 33′. 15″. makes 1 *h.* 33′ 34″.

I know the common way for giving the Suns

Right Ascension is by making a Table of the days of the month, and giving the Suns *Right Ascension* to the days. But this way, if it be *general*, and not appropriated to a certain year, is not accurate to a minute or two: and if it be *adapted* to a *certain* year, 'tis not *general*, and will not serve another time. Whereas our Tables of the Suns *Right Ascension* are *general*, most *accurate* to a second, and *perpetual*.

CHAP. X.

Concerning the Astronomical Equation of Time, and the Tables thereof.

BEing now upon the business of Time, and the accurate observation thereof, so as thereby to regulate curious Time-keepers; it will not be improper to our subject to speak something of the *Inequality* of natural Days; a matter that has exercised the thoughts of all Astronomers in all ages: And though all have allowed that there really is such an *Inequality*, yet they have much disagreed in assigning its quantity, or demonstrating the reason and affections thereof; till at last our most Learned and Ingenious *English* Astronomer, and my Honoured Friend Mr. *John Flamsteed Math. Regius*, has determined the Controversy, and

and by most evident demonstrations has put the matter beyond further dispute, clearly evincing both the Reasons, Affections, and Quantity of this *Inequality*. His *Dissertation* concerning this is annex'd and publish'd at the end of the *Opera Posthuma Jeremiæ Horroxcii*, *Lond*. 1673. 4to. From which (with my esteemed Friend's leave) I shall present the Reader with the following Schemes and Demonstrations.

On account of the Suns *Excentricity* from the center of the Earths *Annual Orbit*, the *Diurnal* motion of the Earth is sometimes faster, and sometimes slower than the *mean* motion, and consequently the *apparent* Day is sometimes longer, and sometimes shorter than the *mean* Day. Which *Inequality*, and the Quantity of the difference of the *equal* or *mean* Day from the *apparent*, is thus demonstrated from the 13 Figure, according to the *Copernican System*.

Let *A B P N* be the great *Orbit* in which the Earth is yearly carried about the *Sun*, the center hereof is *C*, *A* the *Aphelion*, or the Earths place at Noon on that day that it is in its *Aphelion*, suppose the 18*th*. of *June*. *B* the Earths place at Noon the day following. *A L* an assigned *Meridian* of the Earth. The arch *A B*, or the angle *ACB*, the mean motion of the Earth from the Noon of a given day, to the Noon of the day following. *L* a point in the given *Meridian* turn'd to the *Sun*; which point,

point, whilst the Earth is carried in its *Orbit* from *A* to *B*, is rould by the *diurnal circumvolution* of the Earth from *L* through *O* in the first place *A* to *d* in the second place *B*; to which place, when the said point arrives, 'tis manifest that the Earth has performed a compleat revolution about its own *Axis*; because the *meridian B d*, in this its second posture at *B*, is made parallel to *A L* its yesterdays posture at *A*. But it is not yet apparent Noon, till the same point of the Earth by its revolution be brought to *e*, where 'tis turn'd directly opposite to the *Sun*, who governs the Civil Days. And that this time is not the same with the *Cælestial* or *equal* Noon, will be proved, not only because the Earth has not yet performed its *mean* motion above its revolution, (tho this were a sufficient argument) but also because the *diurnal* motions about the *Sun*, and consequently the returns of any certain *meridian* to him, are very *unequal*; neither can they possibly be *equal* in respect of any point about which the Earth is not carried *equally*, as is sufficiently manifest from the inspection of the *Scheme* only. Wherefore the mean Noon and equal Time respects the point of the mean motion (*that is the center of the Orbit C*) and in our present instance is then when the *meridian* carried from *e* arrives at *f*, where 'tis directly opposite to the center of the *Orbit C*. And when it has gained this posture, the Earth has

per-

performed its mean motion above a revolution requisite to compleat a mean day. For the arch *d f* or the angle *d B f* is equal to the angle *A C B* the mean *diurnal* motion of the Earth. Also the arch *d e*, which the Earth, or any *meridian* therein, must pass more than a revolution before it be apparent Noon, is equal to the angle *A S B* the apparent motion of the Earth at the Sun. From whence 'tis evident, that the arch *e f*, which the circumference of the rouling Earth performs between the apparent and mean Noon, and which shews the difference between the apparent and mean Day, is equal to the angle *S B C*, which is the *Equation* of the *Orbit*. Wherefore the *Prosthaphæreses* of the *Orbit* resolved into parts of time, shall be the *Æquations* of time; which *Æquations*, throughout this *semicircle* of *Anomoly* are negative, or to be substracted from the *apparent* time, for herein the *mean* Noon succeeds the *apparent*.

In like manner, if we take the opposite parts of the Scheme, and consider the Earth in its *Perihelion*. The point *g*, or the *meridian n g*, being made parallel to its yesterdays posture, 'tis plain that the Earth has performed one compleat revolution. This point being carried to *h*, where 'tis opposite to the center of the *Orbit*, 'tis now mean Noon; for the arch *g h*, or the angle *g N h* equal to the mean *diurnal* motion of the Earth, is passed over. But it is not *yet* apparent Noon, till the Earth

Earth by its rouling brings the ſame *meridian* to *k*, where 'tis directly oppoſite to the Sun. From whence 'tis manifeſt that the *apparent* Day exceeds the *mean* by ſo much time as is requiſite for the earth to paſs the arch *h k*, which arch is equal to the angle *C N S* the *Proſthapheresis* of the *Orbit*: wherefore reſolving this into time, we have the *Æquation* of time, which throughout this *ſemicircle* of *Anomoly* is *affirmative*, or to be added to the apparent time, becauſe herein the *mean* Noon precedes the *apparent*.

'Tis manifeſt from what foregoes, that if the Sun were in the center of the great *Orbit*, and the Earths *Axis* were not *inclined* to its path or way, there would be no *Inequality* of time, but the mean Day and apparent would be equal. Moreover, if there were no *excentricity* of the Sun from the center of the *Orbit*, but there were the uſual inclination of the Earths *Axis* to the *Orbit*, tho there would no *Inequality* of time ariſe ſuch as is ſhewn in the foregoing demonſtration; yet there would ariſe another *Inequality* from the ſaid inclination of the Earths *Axis*, or as the *Ptolomaicks* would expreſs it, from the inclination of the *Ecliptick* to the *Æquator*; the quantity and affections of which *Inequality* is thus ſhewn by the *Analemma*.

In *Fig.* 14. *P C F* is a Quadrant of the *Solſtitial Colure*, *P* the *Pole*, *A F* a *Radius* of the *Æquator*, *C A* a

Radius

Radius of the *Ecliptick*, *A* the *Equinoctial* point, or the place of the Sun in the beginning of ♈ at noon on ſome certain day, ⊙ the Suns place at noon the day following; through which place ſtriking the arch *P* ⊙ *B perpendicular* to the *Æquator*, *A* ⊙ will expreſs the *diurnal* motion of the Sun, and *A B* its *Right aſcenſion*, or the arch of the *Æquator* that *Culminates* with the Sun. Which arch, ſeeing 'tis one of the ſides of a Right-angled *Triangle A* ⊙ *B*, cannot be equal to the *Hypotenuſe*, that is, to the Suns motion *A* ⊙. Wherefore ſeeing the revolutions of the *Æquator*, and of its *equal* or like parts, are *equable*, and performed in *equal* times, but the Sun in paſſing equal parts of the *Ecliptick* applies to the *meridian* with *unequal* parts of the *Æquator*; it neceſſarily follows that the *ſolar* days are *unequal*. And that the difference between the Suns true place and its *Right aſcenſion* being converted into time, is the true *Æquation* of time ariſing from this cauſe. Which *Æquation*, in the firſt and third *Quadrants* of the Zodiack is to be ſubſtracted from the *apparent* time, for in them the *longitude* of the Sun from the next *Equinoctial* point paſſes the *meridian* ſooner than a like arch projected in the *Æquator*. But in the 2*d* and 4*th Quadrants* of the Zodiack this *Æquation* is to be added to the *apparent* time to get the *mean*; for in theſe the *longitude* of theSun from the *Æquinox* paſſes the *meridian* later than the like Arch projected in the

Æquator. For example, let the *longitude* of the Sun from the first point of ♈ be ⊙ *A.* 0°. 59'. 08". its *Right ascension*, or the arch of the *Æquator culminating* therewith *AB* will be 0°. 54'. 13". their difference 4'. 55". being converted into time is 00^{h} 00'. 19". 40''', and by so much is the *apparent* day shorter than the *mean.* This therefore is the *Æquation* of time arising from this cause, and is negative, or to be substracted from the *apparent* time, to obtain the *mean* time; for the *longitude* of the Sun arrives at the *meridian* sooner than a like arch projected in the *Æquator.*

Here are therefore demonstrated two sorts of *Æquations* of time arising from two different causes, if they are both to be added, or both to be substracted, their sum is to be added or substracted; but if one be to be added, and t'other substracted, their difference according to the nature of the greatest is to be added or substracted to or from the *apparent* time to get the *mean.*

And thus far I have presumed to borrow from my Learned and Ingenious Friend's Discourse; which is sufficient, I think, to put this matter out of all dispute.

After clearing the *Theory* of this Doctrine, I come next to apply it to practice in regulating curious Time-keepers, which indeed are very often abused for want of the due consideration and right application of this *Æquation* of time. For

at

at some time of the year it happens that if our *Watches* or *Oscillating Pendulums* do not differ above a quarter of an hour from the time shew'd by the Sun or Stars, they are false, and need a correction. And the reason of this is plain, for if a *Pendulum-Watch* goes true, it goes *equal*, that is, one 24 hours at any time of the year, is as long as another 24 hours at any other time of the year, and this perpetually and constantly; that is, all Watches that go true, measure the *equal* or *mean* time, and consequently ought to differ from the *apparent* time shewn by a *Sun-dial* or other Instrument, as much as is the *Æquation* of time in excess or defect; but the *Æquation* of time is sometimes above a quarter of an hour, therefore so much ought a good-going *Pendulum-watch* to differ sometimes from the Sun, if it be rightly adjusted. But this will be more evident by explaining the Tables. These are calculated by the foregoing *Theory*, and will serve very well for these 20 years to come; though it must be confest, that to have them most accurate, these Tables ought to be Calculated for every year, as is manifest to those that consider the foregoing *Theory*. Yet I say, these will serve very well for 20 years to come, without any considerable error. Some few seconds error there may be, and he that desires them more exact, may be at the pains of Calculating them himself; the method whereof he may find laid down

in the forementioned Treatise at the end of *Horrox*'s Works; or in Mr. *Flamsteed's Doctrine of the Sphere* publish'd in *Sir J. Moore's System of Mathematicks*. We see there are only four days in the year on which the *æquations* of days cease, that is, the *apparent* and *mean* time are then the same, *viz.* on the 4*th.* of *April*, *June* the 6*th. Aug.* the 21*st.* and *Decemb.* 13. If on any of these days we Set a well-regulated *Pendulum-watch* to the *apparent* time shewn by the Sun or Stars, on any day afterwards, it ought to differ from the *apparent* time shewn by the Sun so much as is the *Æquation* of time in the Table. If the *Æquation* is to be substracted, the *Pendulum* ought to be so much slower than (or behind) the Sun; if the *Æquation* is to be added, the *Pendulum* ought to be so much faster than (or before) the Sun. For upon any day of the year observing the time exactly by Sun or Stars, that time is the *apparent* time, and to gain the *mean* time which ought to be shewn by the Clock, we are to add too or to substract from the said *apparent* time, the *Æquation* answering to the day of our observation. Suppose for instance, on the 4*th* of *April* I observe the time by the Sun, here because the *Æquation* ceases, the *apparent* and *mean* time are the same, and therefore I am to set my Clock to the exact and full time, as the Sun or Stars shew it; but if the *Pendulum* go exactly true, and it move to the 4*th* of *May*, I shall find it 4'. 17'' behind

the

the Sun, for so much is the *æquation* on the 4*th* of *May* to be substracted from the *apparent* time of the Sun to gain the *mean* time of the Clock; that is, when the *Sun* shews it to be 9 a Clock in the morning, the Clock ought to be but 8 *h*. 55'. 43''. And if I find the *Pendulum* more or less behind the *Sun*, it has not gone truly as it ought, but the *Pendulum* or *swagg* is to be lengthned or shortned as is requisite to make it gain or lose the difference betwixt the time shewn by the Clock, and 8 *h*. 55'. 43''. in 30 days elapsed between the 4*th* of *April*, and 4*th* of *May*; according to a Table, whose use I shall declare presently. But if the Movement be exquisitely true, if it go to the 6*th* of *June*, it will again shew the same time with the *Sun* or *Stars*, for then again the *Æquation* is nothing. And if it go onwards exactly to the 3*d* of *August*, it will be 4'. 18''. before the *Sun*; for at that time so much is the *æquation* to be added to the *apparent* time to make it the *mean*. 'Till again on the 24*th* of *October* the Watch ought to be 16'. 4''. behind the *Sun*, for so much is the *æquation* on that day to be substracted.

Wherefore if at any time we set our *Pendulum-Watch* in order to rectify it, and bring it exactly to measure the *mean* day, we are to add to or substract from the *apparent* time shewn by the *Sun* so much as is the *æquation* of days at the time we set it. For example, at noon, or just when the

the *Sun* is in the *Meridian* on the *9th* of *September*, that is, when the *apparent* time is exactly 12 a Clock, I set my Watch, the *æquation* is then 6'. 26". *subtr.* Wherefore I set my Watch to 11 *h.* 53'. 34". Which, if it go right, that is *equally* as it ought, on the *9th* of *October* will be 14'. 52". behind the the *Sun*; if it be either more or less behind or before the *Sun*, it has gone false, and is to be rectified by lengthning or shortning the *Pendulum* as much as is requisite to make it gain or lose the difference between 14'. 52" behind the *Sun* and its error whatever it is in 30 days time elapsed between the *9th* of *Septemb.* and *9th* of *Octob.* But if at any other time of the year we set our Watch when the *æquation* is to be added, we must put it so much before the Sun as is the *æquation.* But this is plain enough without further Illustration.

Of the certainty and exactness of this *æquation* of time, I have made a most convincing Experiment by an exquisitely rectified *Pendulum-Clock*, which I bought from Mr. *Richard Jarrat* Watchmaker in *Lothbury*, *London*, whom I can therefore recommend for his honesty and ability.

And because I have spoken in this Chapter of lengthning or shortning of a *Pendulum*, so as to make it go slower or faster so much in a certain time; for doing this more regularly, and not by guess, I have here added a Table adapted to a *Pendulum*

dulum that *Vibrates seconds*, which is supposed to be 39.2 inches long. Sir *Jonas Moore* in his *Mathematical Compendium*, *pag.* 113 gives us such a Table as this, but whether by the fault of the Printer or Calculator 'tis very erronious, as any one may find that will be at the pains to examine it by the following Rules for Calculating these Tables. The Rule is, *the lengths of Pendulums are to each other reciprocally as the squares of their vibrations in the same time.* Thus, if a *Pendulum* 39.2 inches long *vibrate* 60 times in a minute, how oft will a *Pendulum* 9.8 (*viz.* quarter of 39.2) inches *vibrate* in a minute? by the foregoing Rule the proportion stands thus, 9.8 : 39.2 :: 3600 : 14400, whose square Root is 120; therefore a *Pendulum* 9.8 will *vibrate* 120 times in a minute. So if it be required how oft a *Pendulum* 39.0 inches *vibrates* in a minute, the *Analogy* will be this, 39.0 : 39.2 :: 3600: 3618. whose square Root is 60.15. that is, a *Pendulum* 39.0 inches long *vibrates* in a minute 60 times, and 15 hundreds of a *vibration* more than 60 times. So that multiplying 15 hundreds of a *vibration* by 1440 the number of minutes in 24 hours, we get the number of *vibrations* which a *Pendulum* 39.0 inches long *vibrates* in a day more than one of 39.2; and seeing each *vibration* of the *Pendulum* in a Clock adapted for it, sets the hand forward a second, by knowing the number of *vibrations* which a *Pendulum* 39.0 inches long performs in a

day more than a *Pendulum* 39.2 inches long, we may know the number of seconds which it will advance the *Index* of the Clock forward more than one 39.2 inches long. And by these Rules are the following Tables Calculated.

1	2	3	4
38.7	60''.3863	9'. 16''. 16'''	1'. 52'' 06'''
38.8	60.3084	7 . 24 . 10	1 . 51 . 40
38.9	60.2309	5 . 32 . 30	1 . 51 . 20
39.0	60.1536	3 . 41 . 10	1 . 50 . 40
39.1	60.0766	1 . 50 . 20	1 . 50 . 20
39.2	60.0000	0 . 00 . 00	
39.3	59.9236	1 . 50 . 00	1 . 50 . 00
39.4	59.8475	3 . 39 . 36	1 . 49 . 36
39.5	59.7717	5 . 28 . 45	1 . 49 . 09
39.6	59.6962	7 . 17 . 30	1 . 48 . 45
39.7	59.6210	9 . 05 . 45	1 . 48 . 15

The first Column has in the middle the length of the *Pendulum* 39.2; upwards it diminisheth one tenth, and downwards it increaseth one tenth. The second Column is the *vibrations* and parts of a *Vibration* performed in a minute by the lengths in

in the first. The third Column is the minutes and seconds that these lengthnings and shortnings of the *Pendulum* will cause in a day, and are gotten by multiplying 1440' the minutes in a day by the *Decimals* above or under 60''. The *4th* and last Column are the differences of the *3d.* The like Table may be made to any length of a *Pendulum*, respect being had to the foregoing Rule.

I shall conclude all relating to my *Dial* with the Calculation of hours and minutes for an *Horizontal Dial* for the *latitude* of *Dublin* 53°. 20'. Which I believe will not be unacceptable to those that design curious *Dials* for that place.

The Tables follow amongst the others.

CHAP. XI.

Of the Tables of the Circumpolar Stars, their Calculation and Uses.

I Shall here, as a conclusion to this Work, add something concerning very useful Tables for shewing the time of night very accurately, and other operations by the *Circumpolars*, or Stars that never set in our *latitude* of *Dublin.* Such Tables as these we have mentioned in Sir *J. Moore*'s *Mathematical Compendium p.* 118, 119. but they are for the *latitude* of *London*; neither does he give us all their

uses, or the method of Calculating them for other places. I shall do both in this place, and first for their use.

In any *Northern* Window, or other convenient place, hang up a good weighty Plummet by a fine and even silk or silver-wire, then placing your eye at some distance behind this thred, that is, to the *South* thereof, observe when any of the Stars mentioned in the Table are cut by this thred at the same time with the *Stole-Star.* *From the Stars Right ascension in the Table (adding 24 hours if need be) substract the Suns right ascension, the remainder gives the hour, minute, and second of the night.* The Tables consist of 6 Colums, the first shews the *Magnitudes*; the second contains the *Stars* names, as they are described on our common *English Globes*; the third shews the *Right ascension* of the *Mid-heaven* in time, when any of these Stars come in the same *Vertical* with the *Pole-Star*, by which (working according to the foregoing Rule) we find the hour of the night; the fourth Column gives the *difference* in *time* between the coming of any of these Stars under the *Pole-star*, and their coming under the *Pole* it self. Some of these *Stars* pass the *Meridian*, or come under the *Pole* before they come under the *Pole-Star*, such as are all the *Stars* whose *Right ascensions* are above 9°. 14'. 10", and under 189°. 14'. 10". And of these we say nothing in this place, only they are all marked in the Table

e with *E*, as having their *Azimuth* when under e *Pole-ſtar Eaſtward.* But of theſe Stars in this talogue which paſs the *Meridian*, or come under e *Pole* after they have left the *Vertical* of the le-*ſtar*, we make this following uſe. All theſe e marked in the ſixth Column with *W*, as ha- ng a *Weſtern Azimuth* when they are under the le-*ſtar*. Wherefore placing a ſecond *line* and mmet behind, or to the *South* of the former, then ſerve by the firſt when any of theſe Stars come ider the *Pole-ſtar*, and by a *Pendulum* from that ſtant count the time in this fourth Column, d placing your eye now behind both the lines, ſt at the end of your count by gently moving is laſt thred, make them both cut the *Star* you unt for, then are theſe two lines exactly in the *ridian*; and is a curious way for finding a *Me- ian line*. The fifth and ſixth Columns ſerve for e ſame uſe; for when any of theſe *Stars* are un- r the *Pole-ſtar*, making your two lines cut both le-*ſtar* and t'other, theſe two lines hang ſo far it of the *Meridian line*, as is the *Azimuth* expreſſed the Table, which *Azimuth* is ſhewn to be *Eaſt* *Weſt* by the *6th* Column. Wherefore this angle being ſet off from the found line, ſhews the true *Meridian.* And we may obſerve, that there are three *ſtars* expreſſed in the Table, which being under the *pole-ſtar* are inſenſibly nigh the *Meri- dian*, theſe are *Caſſiopeia's Hipp*, *Cor Caroli*, and *Aliot*

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ufes, or the method of Calculating them for othe
places. I shall do both in this place, and first fo
their use.

In any *Northern* Window, or other convenie
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fine and even silk or silver-wire, then placing you
eye at some distance behind this thred, that is,
the *South* thereof, observe when any of the Sta
mentioned in the Table are cut by this thred
the same time with the *Stole-Star*. *From the Sta
Right ascension in the Table (adding 24 hours if ne
be) substract the Suns right ascension, the remainder giv
the hour, minute, and second of the night.* The Tabl
consist of 6 Colums, the first shews the *Magn
tudes*; the second contains the *Stars* names, as the
are described on our common *English Globes*; th
third shews the *Right ascension* of the *Mid-heave*
in time, when any of these Stars come in th
same *Vertical* with the *Pole-Star*, by which (work
ing according to the foregoing Rule) we find th
hour of the night; the fourth Column gives th
difference in *time* between the coming of any o
these Stars under the *Pole-star*, and their coming
under the *Pole* it self. Some of these *Stars* pass
the *Meridian*, or come under the *Pole* before they
come under the *Pole-Star*, such as are all the *Stars*
whose *Right ascensions* are above 9°. 14'. 10", and
under 189°. 14'. 10". And of these we say nothing
in this place, only they are all marked in the Ta-
ble

ble with *E*, as having their *Azimuth* when under the *Pole-ſtar Eaſtward*. But of theſe Stars in this Catalogue which paſs the *Meridian*, or come under the *Pole* after they have left the *Vertical* of the *Pole-ſtar*, we make this following uſe. All theſe are marked in the ſixth Column with *W*, as having a *Weſtern Azimuth* when they are under the *Pole-ſtar*. Wherefore placing a ſecond *line* and *plummet* behind, or to the *South* of the former, then obſerve by the firſt when any of theſe Stars come under the *Pole-ſtar*, and by a *Pendulum* from that inſtant count the time in this fourth Column, and placing your eye now behind both the lines, juſt at the end of your count by gently moving this laſt thred, make them both cut the *Star* you count for, then are theſe two lines exactly in the *meridian*; and is a curious way for finding a *Meridian line*. The fifth and ſixth Columns ſerve for the ſame uſe; for when any of theſe *Stars* are under the *Pole-ſtar*, making your two lines cut both *Pole-ſtar* and t'other, theſe two lines hang ſo far out of the *Meridian line*, as is the *Azimuth* expreſſed in the Table, which *Azimuth* is ſhewn to be *Eaſt* or *Weſt* by the *6th* Column. Wherefore this angle being ſet off from the found line, ſhews the true *Meridian*. And we may obſerve, that there are three *ſtars* expreſſed in the Table, which being under the *pole-ſtar* are inſenſibly nigh the *Meridian*, theſe are *Caſſiopeia's Hipp*, *Cor Caroli*, and *Aliot*

or the *Great Bears Rump.* Wherefore whenever we have any of these under the *pole-ſtar*, we may by it find a *Meridian line* without any ſenſible error. Another uſe that we may make of this Table, is for the true adjuſting of *Hour-glaſſes* and other *Time-keepers*, as *Pendulum-Watches, &c.* for trying their going, and bringing them to their right meaſure. Thus we ſhall find it juſt four hours (wanting one ſecond) between the coming of *Cor Caroli*, and the 24*th Star* of *Draco* (in *Tich. Catal.*) under the *Pole-ſtar*; for when *Cor Caroli* is under the *pole-ſtar*, the *Right Aſcenſion* of the *Mid-heaven* in time is 00*h.* 36'. 44". And when the 24*th* of *Draco* is under the *pole-ſtar*, the *mid-heavens temporary Right Aſcenſion* is 4*h.* 36'. 43". their difference is 3*h.* 59'. 59". which wants only one ſecond of four hours. Note that this 24*th* of *Draco* is marked in *Bayer* by ε.

I come now to ſhew the method of Calculating this Table, for which ſee the 15 and 16 Figures. Wherein *a x b p* is the circle deſcribed by the *pole-ſtar x* round the *pole p*, *z* the *Zenith*, *z n* the *meridian*, whoſe *North* part is *p n*, *s* is any other *Circumpolar ſtars*, *z x s* a *Vertical circle*, *h n* the *Horizon*, *æ q* the *Æquator*, *p o* the *Axis Mundi.* There are here given (or at leaſt may be known from the Tables) *p x* the Complement of the *pole-ſtars Declination*, *p s* the Complement of the other *ſtars Declination*, *x p s* the difference of the *Right Aſcenſions*

of

of the *pole-ſtar*, and other *ſtar*, alſo *z p* the Complement of the *Poles Elevation*. Wherefore, in the *Triangle s p x*, having *s p*, *p x*, and the angle *s p x*, we may find the angle *s x p*; and having that, we have the angle *p x z*, for this is the Complement of *s x p* to 180 degrees. Then in the *Triangle z p x*, we have *z p*, *p x*, and the angle *p x z*, to find the angle *p z x*, which is the *Azimuth* that theſe two *Stars* have, when they come in the ſame *Vertical*, and makes the fifth Column in our Table. And from the ſame *Data*, we may find the angle *z p x*. Therefore in the *Triangle z p s*, we have found the angle *z p s*, for *z p s* is equal to the ſum of *z p x* and *s p x*. Now the difference between *z p s* and 180 degrees is equal to the difference in time between the Star *s* coming under the *Pole-ſtar* and coming under the *Pole*, or its being in the *Meridian*, and conſequently its having its own *Right Aſcenſion*, or its Complement; and this makes the fourth Column in our Table. Now this difference in time between the *Pole* and *Pole-ſtar* being added to or ſubſtracted from the true *Right Aſcenſion* of the Star *s* in time, gives the *Right Aſcenſion* in time of the Star *s* (or of the *mid-heaven*) when 'tis under the *Pole-ſtar*; and this makes our third Column in the Table. The Rule to know when this difference in time between the *Pole* and *Pole-ſtar* is to be added, and when to be ſubſtracted, will be evident by obſerving, that all ſuch *Stars* whoſe *Right*

Aſcen-

Ascensions are above the *Right Ascension* of the *Pole-star* (for the year, as for 1680) 9°. 14'. 10", and under 189°. 14'. 10". pass the *meridian* before they come under the *Pole-star*; all the other *semicircle*, contrarily; for if the Star pass the *meridian* before it comes under the *Pole-star*, this difference in time between the *Pole* and *Pole-star* is to be added to the *Right Ascension* of the *Star*; if the contrary, 'tis to be substracted.

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Ascensions are above the *Right Ascension* of the *Pole-star* (for the year, as for 1680) 9°. 14'. 10", and under 189°. 14'. 10". pass the *meridian* before they come under the *Pole-star*; all the other *semicircle*, contrarily; for if the Star pass the *meridian* before it comes under the *Pole-star*, this difference in time between the *Pole* and *Pole-star* is to be added to the *Right Ascension* of the *Star*; if the contrary, 'tis to be substracted.

FINIS.

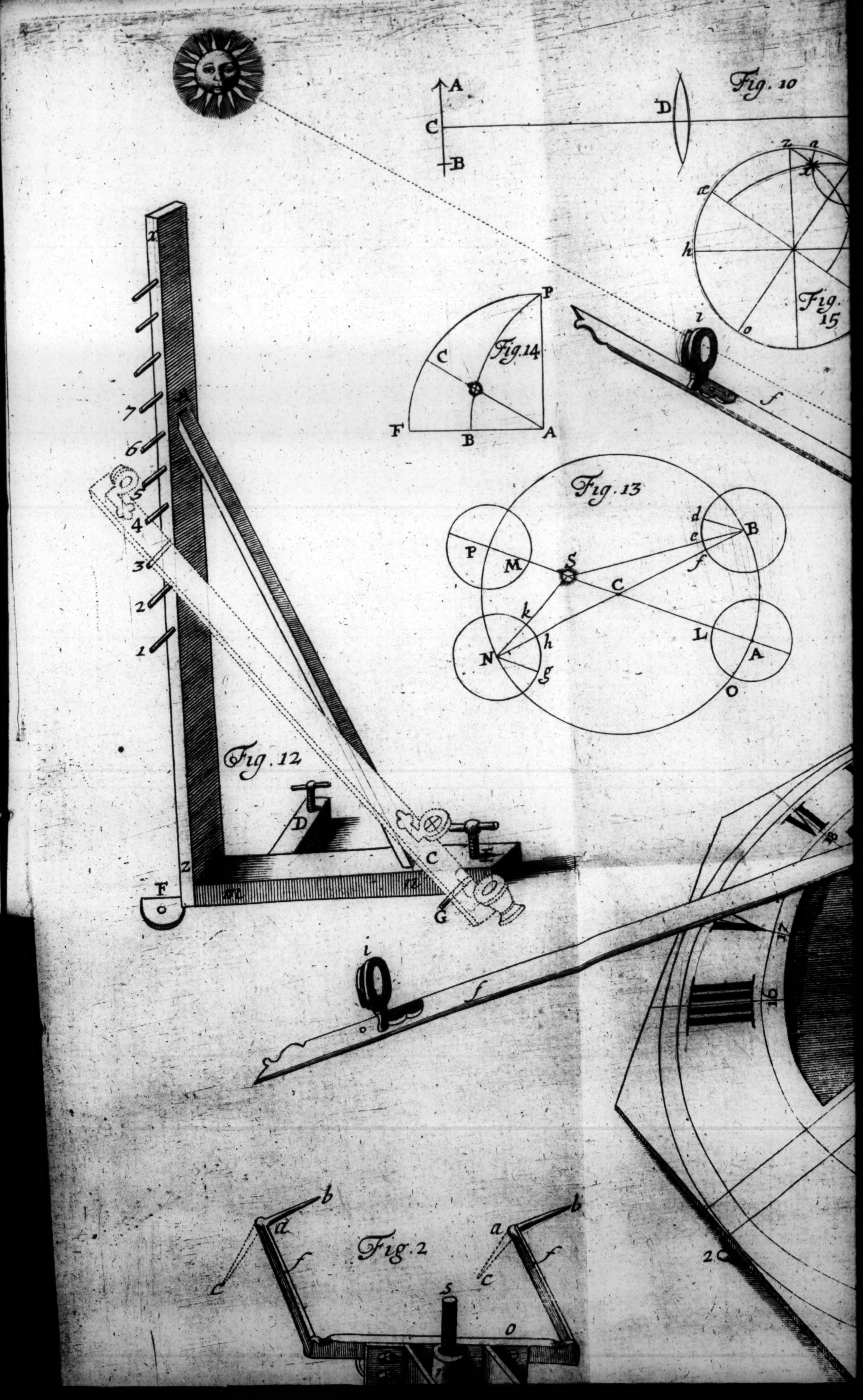


Fig. 10

Fig. 15

Fig. 14

Fig. 13

Fig. 12

Fig. 2

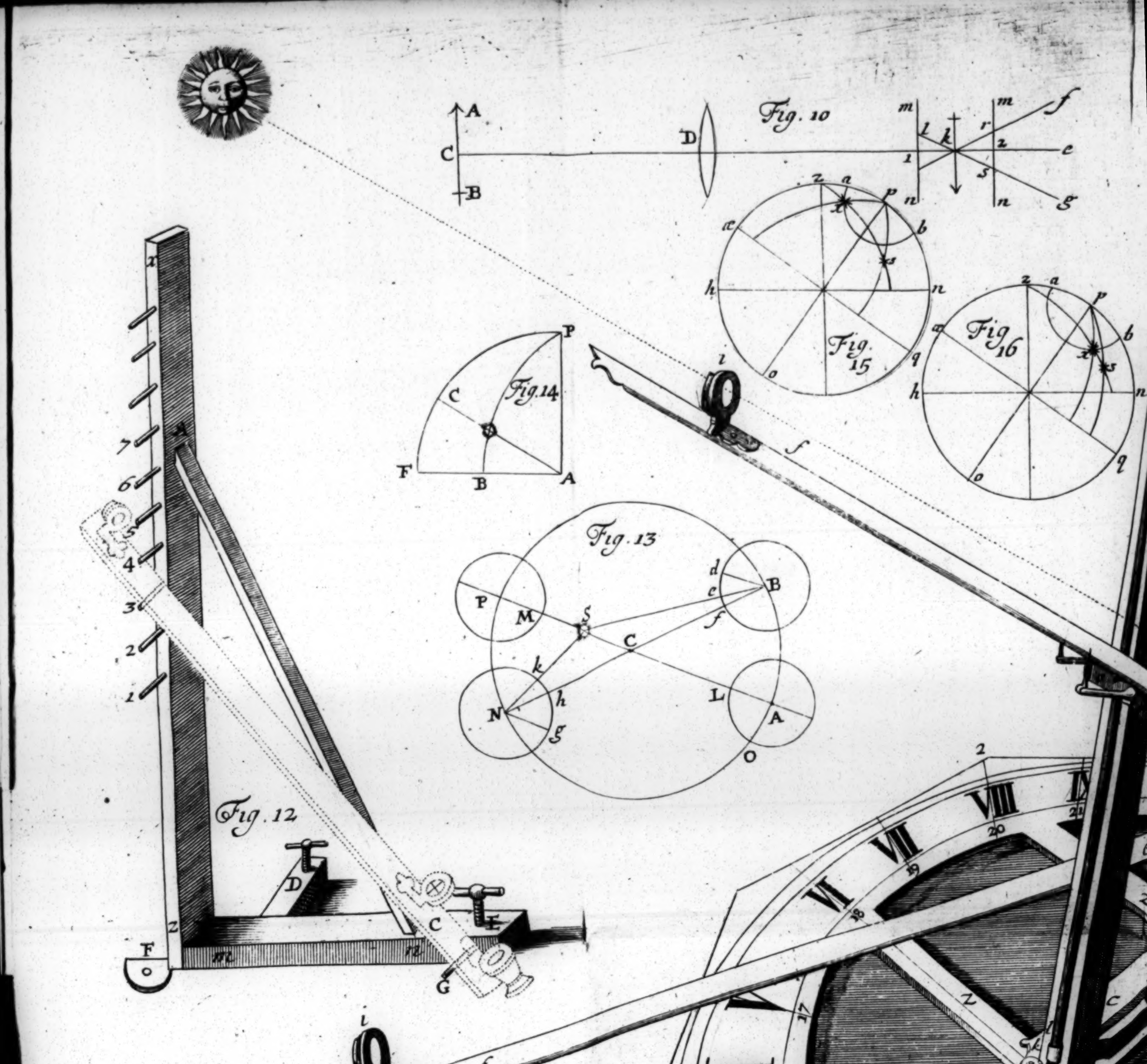
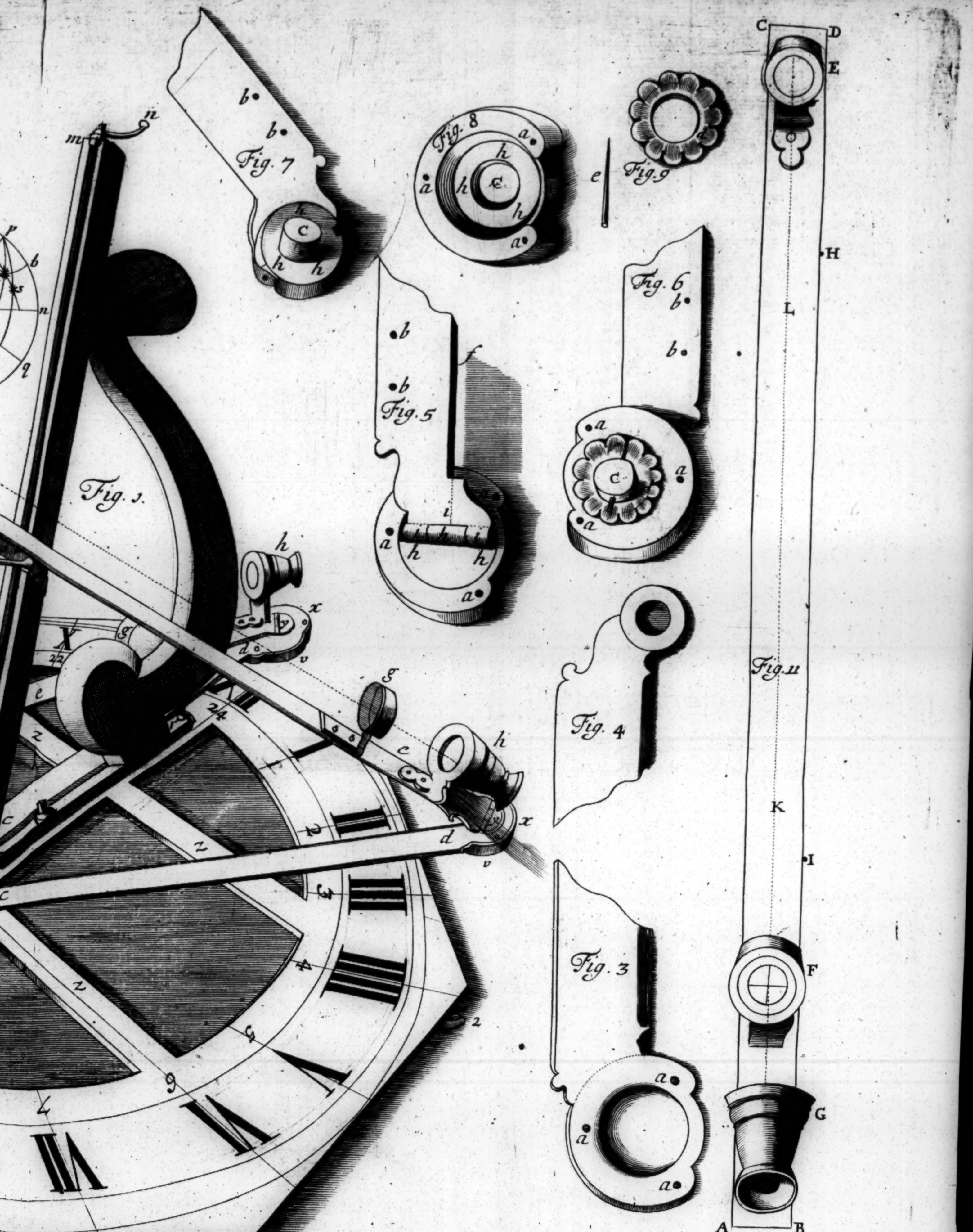


Fig. 10
Fig. 12
Fig. 13
Fig. 14
Fig. 15
Fig. 16
Fig. 2



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TABLES

OF THE

Suns Right Aſcenſion in Time

TO EVERY

Ten Minutes of the ECLIPTICK.

TABLES

OF THE

Suns Right Ascension in Time

TO EVERY

Ten Minutes of the ECLIPTICK.

D. m.	♈ H	♒ H	Com. Pts. ′ ″	X
0. 0	0	12	0. 0	
10	0	12	0.37	″
20	0	12	1.13	37
30	0	12	1.50	
40	0	12	2.27	
50	0	12	3. 3	
1. 0	0	12	3.40	
10	0	12	4.17	″
20	0	12	4.53	37
30	0	12	5.30	
40	0	12	6. 7	
50	0	12	6.43	
2. 0	0	12	7.20	
10	0	12	7.57	″
20	0	12	8.33	37
30	0	12	9.10	
40	0	12	9.46	
50	0	12	10.23	
3. 0	0	12	11. 0	
10	0	12	11.37	″
20	0	12	12.13	37
30	0	12	12.50	
40	0	12	13.26	
50	0	12	14. 3	
4. 0	0	12	14.40	
10	0	12	15.17	″
20	0	12	15.53	37
30	0	12	16.30	
40	0	12	17. 6	
50	0	12	17.43	

D. m.	♈ H	♒ H	Com. Pts. ′ ″	X
5. 0	0	12	18.20	
10	0	12	18.57	″
20	0	12	19.33	37
30	0	12	20.10	
40	0	12	20.46	
50	0	12	21.23	
6. 0	0	12	22. 0	
10	0	12	22.37	″
20	0	12	23.13	37
30	0	12	23.50	
40	0	12	24.26	
50	0	12	25. 3	
7. 0	0	12	25.41	
10	0	12	26.18	″
20	0	12	26.55	37
30	0	12	27.32	
40	0	12	28. 9	
50	0	12	28.46	
8. 0	0	12	29.23	
10	0	12	30. 0	″
20	0	12	30.36	37
30	0	12	31.13	
40	0	12	31.50	
50	0	12	32.26	
9. 0	0	12	33. 3	
10	0	12	33.40	″
20	0	12	34.16	37
30	0	12	34.53	
40	0	12	35.30	
50	0	12	36. 7	

D. m.	♈ H	♎ H	Com. Pts. ′ ″	X
10. 0	0	12	36.44	
10	0	12	37.21	″
20	0	12	37.58	37
30	0	12	38.35	
40	0	12	39.12	
50	0	12	39.49	
11. 0	0	12	40.26	
10	0	12	41. 3	″
20	0	12	41.40	37
30	0	12	42.17	
40	0	12	42.54	
50	0	12	43.31	
12. 0	0	12	44. 7	
10	0	12	44.44	″
20	0	12	45.21	37
30	0	12	45.58	
40	0	12	46.35	
50	0	12	47.12	
13. 0	0	12	47.49	
10	0	12	48.26	″
20	0	12	49.03	37
30	0	12	49.40	
40	0	12	50.17	
50	0	12	50.54	
14. 0	0	12	51.31	
10	0	12	52. 8	″
20	0	12	52.45	37
30	0	12	53.22	
40	0	12	53.59	
50	0	12	54.36	

D. m.	♈ H	♎ H	Com. Pts. ′ ″	X
15. 0	0	12	55.13	
10	0	12	55.50	″
20	0	12	56.27	37
30	0	12	57. 4	
40	0	12	57.41	
50	0	12	58.19	
16. 0	0	12	58. 5	
10	0	12	59.3	″
20	1	13	00.10	37
30	1	13	00.47	
40	1	13	1.24	
50	1	13	2. 2	
17. 0	1	13	2.39	
10	1	13	3.16	″
20	1	13	3.53	37
30	1	13	4.30	
40	1	13	5. 7	
50	1	13	5.45	
18. 0	1	13	6.22	
10	1	13	6.59	″
20	1	13	7.37	37
30	1	13	8.14	
40	1	13	8.52	
50	1	13	9.29	
19. 0	1	13	10. 6	
10	1	13	10.43	″
20	1	13	11.21	37
30	1	13	11.58	
40	1	13	12.36	
50	1	13	13.13	

D. m.	♈ H	♎ H	Com. Pts. ′ ″	
20. 0	1	13	13.50	
10	1	13	14.27	
20	1	13	15. 5	″ 38
30	1	13	15.42	
40	1	13	16.20	
50	1	13	16.57	
21. 0	1	13	17.34	
10	1	13	18.12	
20	1	13	18.50	″ 38
30	1	13	19.27	
40	1	13	20. 5	
50	1	13	20.43	
22. 0	1	13	21.19	
10	1	13	21.57	
20	1	13	22.35	″ 39
30	1	13	23.12	
40	1	13	23.50	
50	1	13	24.28	
23. 0	1	13	25. 5	
10	1	13	25.42	
20	1	13	26.20	″ 39
30	1	13	26.57	
50	1	13	27.35	
50	1	13	28.13	
24. 0	1	13	28.50	
10	1	13	29.28	
20	1	13	30. 6	″ 39
30	1	13	30.44	
40	1	13	31.22	
50	1	13	32. 0	

D. m.	♈ H	♎ H	Com. Pts. ′ ″	
25. 0	1	13	32.37	
10	1	13	33.15	
20	1	13	33.53	″ 38
30	1	13	34.31	
40	1	13	35. 9	
50	1	13	35.46	
26. 0	1	13	36.24	
10	1	13	37. 2	
20	1	13	37.40	″ 38
30	1	13	38.18	
40	1	13	38.56	
50	1	13	39.33	
27. 0	1	13	40.11	
10	1	13	40.49	
20	1	13	41.27	″ 38
30	1	13	42. 5	
40	1	13	42.43	
50	1	13	43.21	
28. 0	1	13	43.59	
10	1	13	44.37	
20	1	13	45.15	″ 38
30	1	13	45.53	
40	1	13	46.31	
50	1	13	47. 9	
29. 0	1	13	47.47	
10	1	13	48.25	
20	1	13	49.03	″ 39
30	1	13	50.41	
40	1	13	51.19	
50	1	13	51.58	

D. m.	♉ H	♏ H	Com. Pts. ′ ″	″
0. 0	1	13	51.36	
10	1	13	52.14	
20	1	13	52.52	38
30	1	13	53.30	
40	1	13	54. 8	
50	1	13	54.47	
1. 0	1	13	55.25	
10	1	13	56. 4	
20	1	13	56.42	38
30	1	13	57.21	
40	1	13	57.59	
50	1	13	58.38	
2. 0	1	13	59.15	
10	1	13	59.54	
20	2	14	0 .32	39
30	2	14	1 .11	
40	2	14	1 .49	
50	2	14	2 .27	
3. 0	2	14	3 . 6	
10	2	14	3 .45	
20	2	14	4 .23	39
30	2	14	5 . 1	
50	2	14	5 .39	
50	2	14	6 .18	
4. 0	2	14	6 .57	
10	2	14	7 .36	
20	2	14	8 .15	39
30	2	14	8 .53	
40	2	14	9 .32	
50	2	14	10.11	

D. m.	♉ H	♏ H	Com. Pts. ′ ″	″
5. 0	2	14	10.49	
10	2	14	11.28	
20	2	14	12. 7	39
30	2	14	12.46	
40	2	14	13.25	
50	2	14	14. 4	
6. 0	2	14	14.42	
10	2	14	15.21	
20	2	14	16. 0	39
30	2	14	16.39	
40	2	14	17.18	
50	2	14	17.57	
7. 0	2	14	18.35	
10	2	14	19.14	
20	2	14	19.53	39
30	2	14	20.32	
40	2	14	21.11	
50	2	14	21.50	
8. 0	2	14	22.29	
10	2	14	23. 8	
20	2	14	23.47	39
30	2	14	24.26	
40	2	14	25. 5	
50	2	14	25.44	
9. 0	2	14	26.24	
10	2	14	27. 3	
20	2	14	27.41	39
30	2	14	28.20	
40	2	14	28.59	
50	2	14	29.38	

D. m.	♉ H	♏ H	Com. Pts. ′ ″	
10. 0	2	14	30.19	
10	2	14	30.59	″
20	2	14	31.38	39
30	2	14	32.17	
40	2	14	33. 7	
50	2	14	33.46	
11. 0	2	14	34.15	
10	2	14	34.54	″
20	2	14	35.34	39
30	2	14	36.13	
40	2	14	36.51	
50	2	14	37.31	
12. 0	2	14	38.11	
10	2	14	38.51	″
20	2	14	39.31	40
30	2	14	40.11	
40	2	14	40.51	
50	2	14	41.31	
13. 0	2	14	42. 9	
10	2	14	42.49	″
20	2	14	43.29	40
30	2	14	44. 8	
40	2	14	44.48	
50	2	14	45.27	
14. 0	2	14	46. 7	
10	2	14	46.47	″
20	2	14	47.27	40
30	2	14	48. 6	
40	2	14	48.46	
50	2	14	49.25	
15. 0	2	14	50. 5	
10	2	14	50.45	″
20	2	14	51.25	40
30	2	14	52. 5	
40	2	14	52.45	
50	2	14	53.25	
16. 0	2	14	54. 5	
10	2	14	54.45	″
20	2	14	55.25	40
30	2	14	56. 5	
40	2	14	56.45	
50	2	14	57.25	
17. 0	2	14	58. 5	
10	2	14	58.45	″
20	2	14	59.25	40
30	3	15	0. 5	
40	3	15	0.46	
50	3	15	1.26	
18. 0	3	15	2. 6	
10	3	15	2.46	″
20	3	15	3.27	40
30	3	15	4. 7	
40	3	15	4.47	
50	3	15	5.28	
19. 0	3	15	6. 8	
10	3	15	6.49	″
20	3	15	7.29	40
30	3	15	8.10	
40	3	15	8.50	
50	3	15	9.30	

D. m.	♉ H	♏ H	Com. pts. ' "	
20. 0	3	15	10.10	
10	3	15	10.51	"
20	3	15	11.30	41
30	3	15	12.11	
40	3	15	12.51	
50	3	15	13.32	
21. 0	3	15	14.13	
10	3	15	14.53	"
20	3	15	15.34	41
30	3	15	16.15	
40	3	15	16.55	
50	3	15	17.36	
22. 0	3	15	18.17	
10	3	15	18.58	"
20	3	15	19.39	41
30	3	15	20.20	
40	3	15	21. 1	
50	3	15	21.41	
23. 0	3	15	22.22	
10	3	15	23.03	"
20	3	15	23.44	41
30	3	15	24.25	
40	3	15	25.06	
50	3	15	25.47	
24. 0	3	15	26.27	
10	3	15	27.08	"
20	5	15	27.49	41
30	3	15	28.30	
40	3	15	29.11	
50	3	15	29.52	

D. m.	♉ H	♊ H	Com. pts. ' "	
25. 0	3	15	30.33	
10	3	15	31.14	"
20	3	15	31.55	41
30	3	15	32.36	
40	3	15	33.17	
50	3	15	33.58	
26. 0	3	15	34.40	
10	3	15	35.21	"
20	3	15	36.02	41
30	3	15	36.44	
40	3	15	37.25	
50	3	15	38.06	
27. 0	3	15	38.47	
10	3	15	39.29	"
20	3	15	40.11	41
30	3	15	40 53	
40	3	15	41.34	
50	3	15	42.15	
28. 0	3	15	42.55	
10	3	15	43.37	"
20	3	15	44.19	41
30	3	15	45.01	
40	3	15	45.43	
50	3	15	46.21	
29. 0	3	15	47. 4	
10	3	15	47.46	"
20	3	15	48.28	42
30	3	15	49 10	
40	3	15	49.52	
50	3	15	50.33	

D. m.	Ⅱ H	L H	Com. Pts. ′ ″	
0. 0	3	15	51.14	
10	3	15	51.56	″
20	3	15	52.37	42
30	3	15	53.19	
40	3	15	54. 0	
50	3	15	54.42	
1. 0	3	15	55.24	
10	3	15	56. 6	″
20	3	15	56.47	42
30	3	15	57.29	
40	3	15	58.10	
50	3	15	58.52	
2. 0	3	15	59.35	
10	4	16	00.17	″
20	4	16	00.59	42
30	4	16	01.40	
40	4	16	2 .22	
50	4	16	3 . 4	
3. 0	4	16	3.46	
10	4	16	4.28	″
20	4	16	5. 9	42
30	4	16	5.51	
40	4	16	6.33	
50	4	16	7.15	
4. 0	4	16	7.59	
10	4	16	8.41	″
20	4	16	9.23	
30	4	16	10. 5	42
40	4	16	10.47	
50	4	16	11.29	

D m	Ⅱ H	♃ H	Com. pts. ′ ″	
5. 0	4	16	12.11	
10	4	16	12.53	″
20	4	16	13.35	42
30	4	16	14.17	
40	4	16	14.59	
50	4	16	15.41	
6. 0	4	16	16.25	
10	4	16	17. 7	″
20	4	16	17.50	42
30	4	16	18.32	
40	4	16	19.15	
50	4	16	19.57	
7. 0	4	16	20.39	
10	4	16	21.21	″
20	4	16	22. 4	43
30	4	16	22.47	
40	4	19	23.30	
50	4	16	24.12	
8. 0	4	16	24.54	
10	4	16	25.36	″
20	4	16	26.19	
30	4	16	27. 1	43
40	4	16	27.44	
50	4	16	28.26	
9. 0	4	16	29. 9	
10	4	16	29.51	″
20	4	16	30.34	
30	4	16	31.16	43
40	4	16	31.59	
50	4	16	32.42	

D. m.	♊ H	♐ H	Com. pts ' ''	
10.0	4	16	33.25	
10	4	16	34. 8	''
20	4	16	34.51	43
30	4	16	35.34	
40	4	16	36.15	
50	4	16	36.58	
11.0	4	16	37.41	
10	4	16	38.24	''
20	4	16	39. 7	43
30	4	16	39.49	
40	4	16	40.32	
50	4	16	41.14	
12.0	4	16	41.57	
10	4	16	42.40	''
20	4	16	43.23	43
30	4	16	44.05	
40	4	16	44.48	
50	4	16	45.31	
13.0	4	16	46.15	
10	4	16	46.58	''
20	4	16	47.41	43
30	4	16	48.23	
40	4	16	49. 5	
50	4	16	49.48	
14.0	4	16	50.32	
10	4	16	51.15	''
20	4	16	51.58	43
30	4	16	52.41	
40	4	16	53.23	
50	4	16	54. 5	
15.0	4	16	54.51	
10	4	16	55.34	''
20	4	16	56.17	43
30	4	16	57.00	
40	4	16	57.43	
50	4	16	58.26	
16.0	4	16	59. 9	
10	4	16	59.52	''
20	5	6	00.35	43
30	5	6	1.18	
40	5	6	2.01	
50	5	6	2.44	
17.0	5	17	3.28	
10	5	17	4.11	''
20	5	17	4.54	43
30	5	17	5.37	
40	5	17	6.20	
50	5	17	7.04	
18.0	5	17	7.48	
10	5	17	8.31	''
20	5	17	9.14	43
30	5	17	9.58	
40	5	17	10.41	
50	5	17	11.24	
19.0	5	17	12. 8	
10	5	17	12.52	''
20	5	17	13.35	43
30	5	17	14.18	
40	5	17	15.01	
50	5	17	15.44	

D. m.	♊ H	♐ H	Com. Pts. ′ ″	″
20.0	5	17	16.28	
10	5	17	17.12	″
20	5	17	17.55	44
30	5	17	18.39	
40	5	17	19.23	
50	5	17	20. 5	
21.0	5	17	20.48	
10	5	17	21.32	″
20	5	17	22.15	44
30	5	17	22.59	
40	5	17	23.42	
50	5	17	24.26	
22.0	5	17	25. 9	
10	5	17	25.53	″
20	5	17	26.37	44
30	5	17	27.21	
40	5	17	28.04	
50	5	17	28.47	
23.0	5	17	29.30	
10	5	17	30.14	″
20	5	17	30.58	44
30	5	17	31.41	
40	5	17	32.25	
50	5	17	33.08	
24.0	5	17	33.51	
10	5	17	34.35	″
20	5	17	35.18	44
30	5	17	36.02	
40	5	17	36.46	
50	5	17	37.30	

D. m.	♊ H	♐ H	Com. Pts. ′ ″	″
25.0	5	17	38.12	
10	5	17	38.56	″
20	5	17	39.39	44
30	5	17	40.23	
40	5	17	41.06	
50	5	17	41.50	
26.0	5	17	42.33	
10	5	17	43.17	″
20	5	17	44.00	44
30	5	17	44.44	
40	5	17	45.27	
50	5	17	46.11	
27.0	5	17	46.55	
10	5	17	47.39	″
20	5	17	48.22	44
30	5	17	49.06	
40	5	17	49.49	
50	5	17	50.33	
28.0	5	17	51.17	
10	5	17	52.01	″
20	5	17	52.44	44
30	5	17	53.27	
40	5	17	54.11	
50	5	17	54.54	
29.0	5	17	55.38	
10	5	17	56.22	″
20	5	17	57.06	44
30	5	17	57.49	
40	5	17	58.33	
50	5	17	59.16	

D.	m.	♋ H	♑ H	Com. Pts. ' "	
0.	0	6	18	0. 0	
	10	6	18	00.44	"
	20	6	18	1.27	44
	30	6	18	2 01	
	40	6	18	2.44	
	50	6	18	3.28	
1.	0	6	18	4.22	
	10	6	18	5 06	"
	20	6	18	5.50	44
	30	6	18	6.34	
	40	6	18	7.18	
	50	6	18	8.02	
2.	0	6	18	8.43	
	10	6	18	9.26	"
	20	6	18	10.10	44
	30	6	18	10.54	
	40	6	18	11.37	
	50	6	18	12.20	
3.	0	6	18	13. 5	
	10	6	18	13.49	"
	20	6	18	14.32	44
	30	6	18	15.16	
	40	6	18	15.59	
	50	6	18	16.43	
4.	0	6	18	17.27	
	10	6	18	18.11	"
	20	6	18	18.54	44
	30	6	18	19.38	
	40	6	18	20.22	
	50	6	18	21.05	

D.	m.	♋ H	♑ H	Com. Pts. ' "	
5.	0	6	18	21.48	
	10	6	18	22.32	"
	20	6	18	23.15	44
	30	6	18	23.59	
	40	6	18	24.42	
	50	6	18	25.25	
6.	0	6	18	26. 9	
	10	6	18	26.53	"
	20	6	18	27.37	44
	30	6	11	28.20	
	40	6	18	29.04	
	50	6	18	29.47	
7.	0	6	18	30.30	
	10	6	18	31.14	"
	20	6	18	31.57	44
	30	6	18	32.41	
	40	6	18	33.24	
	50	6	18	34.17	
8.	0	6	18	34.51	
	10	6	18	35.34	"
	20	6	18	36.18	44
	30	6	18	37.01	
	40	6	18	37.45	
	50	6	18	38.28	
9.	0	6	18	39.11	
	10	6	18	39.54	"
	20	6	18	40.48	44
	30	6	18	41.31	
	40	6	18	42.15	
	50	6	18	42.58	

D. m.	♋ H	♑ H	Com. Pts. ′ ″ H m	
10. 0	6	18	43.32	
10	6	18	44.15	″
20	6	18	44.59	
30	6	18	45.42	43
40	6	18	46.25	
50	6	18	47. 9	
11. 0	6	18	47.52	
10	6	18	48.35	″
20	6	18	49.18	
30	6	18	50. 2	43
40	6	18	50.45	
50	6	18	51.29	
12. 0	6	18	52.12	
10	6	18	52.55	″
20	6	18	53.38	
30	6	18	54.22	43
40	6	18	55. 5	
50	6	18	55.48	
13. 0	6	18	56.31	
10	6	18	57.14	″
20	6	18	57.57	
30	6	18	58.41	43
40	6	18	59.24	
50	7	19	0. 7	
14. 0	7	19	0.50	
10	7	19	1.33	
20	7	19	2.16	″
30	7	19	3. 0	43
40	7	19	3.43	
50	7	19	4.26	

D. m.	♋ H	♑ H	Com. Pts. ′ ″ H	
15. 0	7	19	5. 9	
10	7	19	5.52	″
20	7	19	6.35	43
30	7	19	7.18	
40	7	19	8. 1	
50	7	19	8.44	
16. 0	7	19	9.27	
10	7	19	10.10	″
20	7	19	10.53	
30	7	19	11.36	43
40	7	19	12.19	
50	7	19	13. 2	
17. 0	7	19	13.45	
10	7	19	14.28	″
20	7	19	15.11	
30	7	19	15.54	43
40	7	19	16.36	
50	7	19	17.19	
18. 0	7	19	18. 2	
10	7	19	18.45	″
20	7	19	19.28	
30	7	19	20.11	43
40	7	19	20.53	
50	7	19	21.36	
19. 0	7	19	22.19	
10	7	19	23. 2	
20	7	19	23.45	″
30	7	19	24.27	43
40	7	19	25.10	
50	7	19	25.53	

D. m.	♋ H	♑ H	Com. Pts. ' ''	
20. 0	7	19	26.35	
10	7	19	27.18	''
20	7	19	28. 0	
30	7	19	28.43	43
40	7	19	29.25	
50	7	19	30. 8	
21. 0	7	19	30.51	
10	7	19	31.34	''
20	7	19	32.16	43
30	7	19	32.59	
40	7	19	33.41	
50	7	19	34 24	
22. 0	7	19	35. 6	
10	7	19	35.49	''
20	7	19	36.31	
30	7	19	37.14	43
40	7	19	37 56	
50	7	19	38 39	
23. 0	7	19	39.21	
10	7	19	40. 3	''
20	7	19	40.46	
30	7	19	41.28	42
40	7	19	42.10	
50	7	19	42.52	
24. 0	7	19	43.35	
10	7	19	44.17	
20	7	19	45. 0	''
30	7	19	45.42	42
40	7	19	46.24	
50	7	19	47. 7	

D. m.	♋ H	♑ H	Com. Pts. ' ''	
25. 0	7	19	47.49	
10	7	19	48.31	''
20	7	19	49.13	42
30	7	19	49.56	
40	7	19	50.38	
50	7	19	51.20	
26. 0	7	19	52.01	
10	7	19	52 43	''
20	7	19	53.25	42
30	7	19	54. 7	
40	7	19	54 50	
50	7	19	55 32	
27. 0	7	19	56.13	
10	7	19	56 55	''
20	7	19	57.37	42
30	7	19	58.20	
40	7	19	59. 2	
50	7	19	59 43	
28. 0	8	20	0.25	
10	8	20	1. 7	''
20	8	20	1.49	42
30	8	20	2. 30	
40	8	20	3. 12	
50	8	20	3.54	
29. 0	8	20	4 36	
10	8	20	5.18	''
20	8	20	6. 0	42
30	8	20	6.41	
40	8	20	7.23	
50	8	20	8. 4	

D.	m.	♌ H	♒ H	Com. pts. ′ ″	
0.	0	8	30	8.46	
	10	8	20	9.28	″
	20	8	20	10.10	42
	30	8	20	10.52	
	40	8	20	11.54	
	50	8	20	12.16	
1.	0	8	20	12.55	
	10	8	20	13.36	″
	20	8	20	14.17	41
	30	8	20	14.58	
	40	8	20	15.39	
	50	8	20	16.20	
2.	0	8	20	17.-4	
	10	8	20	17.45	″
	20	8	20	18.26	41
	30	8	20	19.07	
	40	8	20	19.48	
	50	8	20	20.29	
3.	0	8	20	21.12	
	10	8	20	21.53	″
	20	8	20	22.34	41
	30	8	20	23.15	
	40	8	20	23.56	
	50	8	20	24 37	
4.	0	8	20	25.20	
	10	8	20	26.01	
	20	8	20	26.42	″
	30	8	20	27.23	41
	40	8	20	28.04	
	50	8	20	28.45	

D.	m.	♌ H	♒ H	Com. pts. ′ ″	
5.	0	8	20	29.27	
	10	8	20	30.08	″
	20	8	20	30.49	41
	30	8	20	31.30	
	40	8	20	32.11	
	50	8	20	32.52	
6.	0	8	20	33.33	
	10	8	20	34.14	″
	20	8	20	34.55	41
	30	8	20	35.36	
	40	8	20	36.17	
	50	8	20	36.58	
7.	0	8	20	37.38	
	10	8	20	38.19	″
	20	8	20	39.00	41
	30	8	20	39.41	
	40	8	20	40.22	
	50	8	20	41.03	
8.	0	8	20	41.42	
	10	8	20	42.23	″
	20	8	20	43.04	41
	30	8	20	43.45	
	40	8	20	44.26	
	50	8	20	45.07	
9.	0	8	20	45.46	′
	10	8	20	46.26	″
	20	8	20	47.06	40
	30	8	20	47.46	
	40	8	20	48.26	
	50	8	20	49.06	

D. m.	♌ H	♒ H	Com. pts ' ''	
10.0	8	30	49.59	
10	8	20	50.30	''
20	8	20	51.10	40
30	8	20	51.50	
40	8	20	52.30	
50	8	20	53.10	
11.0	8	20	53.53	
10	8	20	54.33	''
20	8	20	55.13	40
30	8	20	55.53	
40	8	20	56 33	
50	8	20	57.13	
12.0	8	20	57.55	
10	8	20	58.35	''
20	8	20	59.15	40
30	8	20	59.55	
40	9	21	00.35	
50	9	21	1.15	
13.0	9	21	1.55	
10	9	21	2.35	''
20	9	21	3.15	
30	9	21	3.55	40
40	9	21	4.35	
50	9	21	5.15	
14.0	9	21	5.55	
10	9	21	6.35	
20	9	21	7.15	''
30	9	21	7.55	40
40	9	21	8.35	
50	9	21	9.15	

D. m.	♌ H	♒ H	Com. pts ' '' '''	
15.0	9	21	9.55	
10	9	21	10.35	''
20	9	21	11.15	
30	9	21	11.55	40
40	9	21	12.35	
50	9	21	13.15	
16.0	9	21	13.53	
10	9	21	14.33	''
20	9	21	15.13	40
30	9	21	15.53	
40	9	21	16.33	
50	9	21	17.13	
17.0	9	21	17.51	
10	9	21	18.31	''
20	9	21	19.11	40
30	9	21	19.51	
40	9	21	20.31	
50	9	21	21.11	
18.0	9	21	21.48	
10	9	21	22.27	
20	9	21	23.06	''
30	9	21	23.45	39
40	9	21	24.24	
50	9	21	25.03	
19.0	9	21	25.45	
10	9	21	26.24	
20	9	21	27.03	''
30	9	21	27.42	39
40	9	21	28.21	
50	9	21	29.00	

D. m.	♌ H	♒ H	Com. Pts. ′ ″	
20. 0	9	21	29.41	
10	9	21	30.20	″
20	9	21	30.59	39
30	9	21	31.38	
40	9	21	32.17	
50	9	21	32.56	
21. 0	9	21	33.36	
10	9	21	34.15	″
20	9	21	34.54	39
30	9	21	35.33	
40	9	21	36.12	
50	9	21	36.51	
22. 0	9	21	37.30	
10	9	21	38. 9	″
20	9	21	38.48	39
30	9	21	39.27	
40	9	21	40.06	
50	9	21	40.45	
23. 0	9	21	41.24	
10	9	21	42.03	″
20	9	21	42.42	39
30	9	21	43.21	
40	9	21	44.00	
50	9	21	44.39	
24. 0	9	21	45.17	
10	9	21	45.56	″
20	9	21	46.35	39
30	9	21	47.14	
40	9	21	47.53	
50	9	21	48.32	

D m.	♌ H	♒ HH	Com. pts. H ″	
25. 0	9	21	49.10	
10	9	21	49.50	″
20	9	21	50.29	39
30	9	21	51.08	
40	9	21	51.47	
50	9	21	52.26	
26. 0	9	21	53. 2	
10	9	21	53.41	″
20	9	21	54.19	39
30	9	21	54.58	
40	9	21	55.36	
50	9	21	56.14	
27. 0	9	21	56.53	
10	9	21	57.32	″
20	9	21	58.10	39
30	9	21	58.49	
40	9	21	59.27	
50	10	22	00.06	
28. 0	10	22	0.44	
10	10	22	1.22	″
20	10	22	2.00	38
30	10	22	2.39	
40	10	22	3.17	
50	10	22	3.55	
29. 0	10	22	4.34	
10	10	22	5.12	″
20	10	22	5.50	38
30	10	22	6.29	
40	10	22	7.08	
50	10	22	7.46	

D. m.	♍ H	♓ H	Com. Pts. ' ''	
0. 0	10	22	8.24	
10	10	22	9.02	''
20	10	22	9.40	38
30	10	22	10.19	
40	10	22	10.57	
50	10	22	11.35	
1. 0	10	22	12.13	
10	10	22	12.51	''
20	10	22	13.29	38
30	10	22	14.07	
40	10	22	14.45	
50	10	22	15.23	
2. 0	10	22	16. 1	
10	10	22	16.39	''
20	10	22	17.17	38
30	10	22	17.55	
40	10	22	18.33	
50	10	22	19.11	
3. 0	10	22	19.49	
10	10	22	20.27	''
20	10	22	21.05	38
30	10	22	21.43	
40	10	22	22.21	
50	10	22	22.59	
4. 0	10	22	23.36	
10	10	22	24.14	''
20	10	22	24.52	38
30	10	22	25.30	
40	10	22	26.08	
50	10	22	26.46	

D m.	♍ H	♓ H	Com. pts. ' ''	
5. 0	10	22	27.23	
10	10	22	28.01	''
20	10	22	28.39	38
30	10	22	29.16	
40	10	22	29.54	
50	10	22	30.32	
6. 0	10	22	31. 9	
10	10	22	31.46	''
20	10	22	32.24	38
30	10	22	33.01	
40	10	22	33.39	
50	10	22	34.17	
7. 0	10	22	34.55	
10	10	22	35.33	''
20	10	22	36.10	38
30	10	22	36.48	
40	10	22	37.25	
50	10	22	38.03	
8. 0	10	22	38 40	
10	10	22	39.18	''
20	10	22	39.56	38
30	10	22	40 33	
40	10	22	41.10	
50	10	22	41.48	
9. 0	10	22	42 25	
10	10	22	43.02	''
20	10	22	43.40	38
30	10	22	44.17	
40	10	22	44.54	
50	10	22	45.32	

D. m.	♍ H	♓ H	Com. Pts. ′ ″	
10.0	10	22	46.10	
10	10	22	46.47	″
20	10	22	47 25	37
30	10	22	48 03	
40	10	22	48.40	
50	10	22	49.17	
11.0	10	22	49.54	
10	10	22	50.31	″
20	10	22	51.09	37
30	10	22	51.46	
40	10	22	52.23	
50	10	22	53.01	
12.0	10	22	53.38	
10	10	22	54.15	″
20	10	22	54.52	37
30	10	22	55.29	
40	10	22	56.07	
50	10	22	56.44	
13.0	10	22	57.21	
10	10	22	57.58	″
20	10	22	58.34	37
30	10	22	59.12	
40	10	22	59.49	
50	11	23	00.27	
14.0	11	23	1. 4	
10	11	23	1.41	″
20	11	23	2.18	37
30	11	23	2.55	
40	11	23	3.32	
50	11	23	4.09	

D m	♍ H	♓ H	Com. pts. ′ ″	
15.0	11	23	4.47	
10	11	23	5.24	″
20	11	23	6.01	37
30	11	23	6.39	
40	11	23	7.16	
50	11	23	7.53	
16.0	11	23	8.29	
10	11	23	9.06	″
20	11	23	9.43	37
30	11	23	10.20	
40	11	23	10.57	
50	11	23	11.34	
17.0	11	23	12.11	
10	11	23	12.48	″
20	11	23	13.25	37
30	11	23	14.02	
40	11	23	14.39	
50	11	23	15.16	
18.0	11	23	15.53	
10	11	23	16.30	″
20	11	23	17.07	37
30	11	23	17 44	
40	11	23	18.21	
50	11	23	18.58	
19.0	11	23	19.34	
10	11	23	20.11	″
20	11	23	20 48	37
30	11	23	21.25	
40	11	23	22.02	
50	11	23	22.39	

D. m.	♍ H	♓ H	Com. Pts. ′ ″	
20.0	11	23	23.16	
10	11	23	23.53	
20	11	23	24.30	″
30	11	23	25.07	37
40	11	23	25.44	
50	11	23	26.21	
21.0	11	23	26.56	
10	11	23	27.33	
20	11	23	28.10	″
30	11	23	28.46	37
40	11	23	29 23	
50	11	23	30.00	
22.0	11	23	30.37	
10	11	23	31.14	
20	11	23	31.51	″
30	11	23	32.27	37
40	11	23	33.04	
50	11	23	33.41	
23.0	11	23	34.18	
10	11	23	34.55	
20	11	23	35.32	″
30	11	23	36.08	37
40	11	23	36.45	
50	11	23	37.22	
24.0	11	23	37.59	
10	11	23	38.36	
20	11	23	39.13	″
30	11	23	39.59	37
40	11	23	40.36	
50	11	23	41.13	

D m.	♍ H	♓ H	Com. pts. ′ ″	
25.0	11	23	41.40	
10	11	23	42.17	
20	11	23	42.54	″
30	11	23	43.30	37
40	11	23	44 07	
50	11	23	44 43	
26.0	11	23	45.20	
10	11	23	45.57	
20	11	23	46.34	″
30	11	23	47.10	37
40	11	23	47.47	
50	11	23	48.23	
27.0	11	23	49. 0	
10	11	23	49.37	
20	11	23	50.14	″
30	11	23	50.50	37
40	11	23	51.27	
50	11	23	52.03	
28.0	11	23	52.40	
10	11	23	53.17	
20	11	23	53.54	″
30	11	23	54.30	37
40	11	23	55.06	
50	11	23	55.43	
29.0	11	23	56.20	
10	11	23	56.57	
20	11	23	57 34	″
30	11	23	58 10	37
40	11	23	58.46	
50	11	23	59.23	

A Catalogue of some Noted fix'd Stars, with their *Temporary Right Ascensions* to the Year 1686.

The first Column shews their Magnitudes. The second *Bayer*'s Notes. The third the Numbers in *Ticho*'s Catalogue. The fourth *Bayer*'s Latin Names, and common English Names. The fifth their Temporary Right Ascensions.

Mag	Not. Bay.	Num Cat. Tich	Stars Names.	Rt. Ascens. H. ′ ″
3	ι	21	*In Extremitate Boreali Caudæ Ceti* Northern in the Whales Tail	00.03.32
2	β	22	*In Extremitate Australi Caudæ Ceti* Southern in the Whales Tail	00.28.17
3	κ	16	*Præcedens in Eductione Caudæ Ceti* Western in the Back of the Whale	00.54.13
3	θ	15	*Sequens in Eductione Caudæ Ceti* Eastern in the Back of the Whale	01.08.40
3	ζ	14	*In medio corpore Ceti trium Septentrionalior* Northern in the Whales Belly	01.36.05
4	γ	1	*Prima Stella Arietis* First Star of Aries	01.36.22
4	β	2	*In sinistro Cornu Arietis* Second Star of Aries	01.37.04
3	α	19	*In Nodo Vinculorum Piscium* Br * in the Knot of the Fishes Line	01.45.49
3	α	14	*Lucida Arietis* Bright Star of Aries	01.49.29
3	δ	4	*Trium in Collo Ceti Australior* In the Whales Cheek	02.23.43
3	ε	10	*Lateris Sequentis Quadrilateri Borea in Pectore Ceti* On the Whales Brest	02.24.40
3	γ	3	*Media Trium in Collo Ceti* In the Whales Mouth.	02.27.16

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2	α	2	*Lucida in Naribus, Menkar, Ceti* Whales Jaw	02.45.50
3	η	32	*Lucida Pleiadum Tauri* Brighteſt of the Pleiades	03.29.01
3	γ	11	*In Vultu Tauri illa in Naribus* The loweſt of the Hyades	04.01.50
3	ε	15	*Ad Oculum Boreum Tauri* North Eye of Taurus	04.10.08
1	α	14	*Tauri Oculus Auſtrinus. Aldebaran* Bulls South Eye	04.17.56
3	β	2	*Supra Pedem Orionis in Flumine Erid.* Orions Foot in Eridanus	04.52.32
1	β	35	*Pes Dexter Orionis. Rigel* Bright Star in Orions Foot	04.59 29
2	β		*Tauri Cornu Septentrionale* Bulls North Horn	05.06.27
2	γ	3	*In humero Dextro Orionis Duarum Borealior* Firſt or left Shoulder of Orion	05 08.22
2	δ	26	*In Baltheo Orionis Fulgentium 3um precedens* Firſt in Orions Belt	05.15.55
3	ζ	19	*Extrema Cornu Auſtralis Tauri.* Bulls South Horn	05.18.50
2	ε	27	*Media Balthei Orionis* The ſecond or middle in Orions Belt	05.20.08
2	ζ	28	*Sequens ſeu tertia Balthei Orionis* Third or laſt in Orions Belt	05.24.30
1	α	2	*Lucida in Humero ſiniſtro Orionis* The latter or right Shoulder of Orion	05.38.07
3	η	15	*Calx Caſtoris* The Heel of Gemini	05.56 05

				h ′ ″
2	β	9	*In Collario Canis Majoris* The fore-foot of the Great Dog	06.09.13
2	γ	17	*In summo Pede sinistro sequentis* ♊ Bright Star on the Foot of ♊	06.19.25
1	α	1	*Syrius seu Canis Major* The Great Dog Star	06.31.11
3	ζ	11	*In Dextro Genu Herculis* ♊ Left Knee of Gemini	06.45.38
3	γ	4	*Ad Aurem Dextram Canis Majoris* On the Neck of Canis Major	07.11.00
1	α	2	*Procyon seu Canis Minor* The Little Dog	07.22.53
2	α	12	*Cor Hydra, Alphard* Hydra's Heart	09.12.07
3	η	7	*Trium in Cervice Leonis Australior* Southern in the Neck of Leo	09.50.22
1	α	8	*Lor Leonis* Lions Heart	09.51.31
3	ζ	5	*Trium in Cervice Leonis Borealior* Northern in the Neck of Leo	09.59.06
2	γ	6	*Trium in Cervice Leonis Media. Juba* Lions Crest	10.02.27
2	δ	20	*In Lumbis Leonis Duarum quæ Sequitur* In the Loyn of Leo	10.57.21
3	θ	21	*In Vertebra Femoris Dextri Leonis* On the Buttock of Leo	10.57.50
1	β	27	*Cauda Leonis* Lions Tail	11.32.58
3	ι	23	*In Femore Dextro Leonis* On the Thigh of Leo	11.07.44

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3	β	5	*In Extremo Alæ sinistræ Virginis* Above the left wing of Virgo	11.34.31
3	γ	7	*Sub strophio seu Castula Virginis* On the left wing of Virgo	12.25.43
3	δ	10	*Ad Cingulum Virginis* In the Girdle of Virgo	12.39.58
3	ε	13	*Alæ Dextræ ♍ precedens. Vindemiatrix* Virgo's right wing. Vindemiatrix	12.46.46
1	α	14	*Spica Virginis* Virgins Spike	13.08.46
3	ζ	15	*Sub Perizomate ad pedem dextrum ♍* On the Buttock of Virgo	13.13.38
3	κ	20	*In sinistra Tibia Bootis trium Borealior* Most Northern on the left knee of Bootes	13.32.33
1	α	23	*Arcturus* Arcturus	14.01.24
3	ζ	19	*In Dextra Tibia Bootis* Bend of Bootes right knee	14.26.20
2	α	1	*Lanx Australis* Southern Ballance	14.33.46
2	β	3	*Lanx Borealis* Northern Ballance	15.00.15
3	γ	7	*In media lance Boreali Prima & Superior* Middle of the Northern Ballance	15.18.13
2	α	9	*Precedens trium in medio neru colli serpentis* Bright Star in the Serpents neck	15.28.54
2	β	1	*In fronte ♏ ad Boream prima fulgens* Highest in Scorpio's forehead	15.46.04
3	δ	2	*In dextra manu serpentarii Borealior* Northern in the left hand of Serpentarius	15.58.23

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3	ε	8	*Australior in Dextra manu Serpentarii* Southern in the left hand of Serpentarius	16.01.57
3	γ	3	*In sinist. Humero Herculis trium Australior* Hercules Right Shoulder	16.08.07
1	α	8	*Cor Scorpii* Scorpius Heart	16.10.18
3	β	2	*In sinist. Humero Herculis trium Borealior* Northern in Hercules Right Shoulder	16.16.41
3	ζ	19	*In Femore Dextro Serpentarii* Serpentarius left knee	16.19.59
3	θ	13	*In Femore sinistro Serpentarii 3um Borealior* Right Ham of Serpentarius	16.52.02
3	α	1	*Caput Herculis* Hercules Head	17.00.23
3	δ	5	*Herculis Humerus Dexter* Left Shoulder of Hercules	17.01.57
2	α	1	*Caput Serpentarii* Serpentarius Head	17.20.22
3	β	2	*In sinist. Humero Serpentarii 2rum Superior* Northern in Serpentarius right Shoulder	17 27.55
3	γ	3	*In eodem duarum Inferior* Southern in Serpentarius Right Shoulder	17.32.24
3	ζ	16	*Prima post Serpentarium in Cauda Serpentis* Last but two in the Serpents Tail	17.44.09
3	η	17	*In Penultima Flexione Cauda Serpentis* Last but one in the Serpents Tail	18.05 20
3	θ	18	*Extrema Cauda Serpentis* Last in the Serpents Tail	18 40 37
3	[illegible]	11	*Extrema Cauda Aquila* Last in the Eagles Tail	18.51.06

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3	γ	5	*Ad Originem Alæ Dextræ Aquilæ* Pinion of Aquila's Right Wing	19.31.38.
2	α	3	*Lucida in Eductione Colli Aquilæ* Aquila's Bright Star	19.35.51
3	β	2	*In Collo Aquilæ* Neck of Aquila	19.39.57
3	α	1	*Septentrionalis duplex in Cornu Capricorn* Northern in the Horn of Capricorn	20.00.50
3	ε	1	*Lucida Caudæ Delphini trium Antecedens.* Dolphins Tail	20.18.23
3	β	4	*In Humero Dextro Aquarii* Left Shoulder of Aquary	21.14.58
3	γ	23	*In Eductione Caudæ Capricorni Antecedens* First in the Tail of Capricorn	21.22.57
3	ε	1	*In Rictu Pegasi. Enif.* Mouth of Pegasus	21.28.44
3	δ	24	*In Eductione Caudæ Capricorni succedens* Last in the Tail of Capricorn	21.30.07
3	α	2	*Humerus sinister Aquarii* Right Shoulder of Aquary	21.49.43
3	γ	9	*In Lævo Cubito Aquarii* Right Elbow of Aquary	22.05.37
3	δ	18	*In sinistra Tibia Aquarii* Right shin or knee of Aquary	22.38.15
2	β	18	*In Eductione Cruris Pegasi.* Scheat Pegasus Thigh	22.48.43
2	α	17	*Ala Pegasi. Marchab* Pegasus Wing	22.49.05
2	γ	19	*In Exteema Ala Pegasi* End of Pegasus Wing	23.57.03

TABLES
OF
ÆQUATION
OF
Natural Days.

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A Table of Equation of Natural Days.

Day	Jan.		Diff.	Feb.		X	March		X	Apr.		X	May		X	June		X
	′	″	″	′	″	″	′	″	″	′	″	″	′	″	″	′	″	″
	Add			Add			Add			Substract			Substract			Add		
1	8	55		14	54		10	16	18	0	51		4	12		1	10	
2	9	17	22	14	53	1	9	58	18	0	35	16	4	14	2	0	57	13
3	9	40	23	14	51	2	9	41	17	0	18	17	4	16	2	0	45	12
4	10	02	20	14	48	3	9	24	17	0	*01	17	4	17	1	0	33	12
5	10	23	21	14	45	3	9	06	18	0	14	15	4	16	1	0	19	14
			21			5			17			15			1			12
6	10	44		14	40		8	49		0	29		4	15		0	07	
7	11	02	18	14	35	5	8	32	17	0	43	14	4	14	1	0	*06	13
8	11	20	18	14	29	6	8	14	18	0	58	15	4	12	2	0	19	13
9	11	38	18	14	23	6	7	55	19	1	12	14	4	10	2	0	32	13
10	11	55	17	14	16	7	7	37	18	1	26	14	4	08	2	0	44	12
			17			9			19			14			3			13
11	12	12		14	07		7	18		1	40		4	05		0	57	
12	12	28	16	13	59	8	6	58	20	1	52	12	4	01	4	1	10	13
13	12	43	15	13	50	9	6	39	19	2	03	11	3	57	4	1	23	13
14	12	58	15	13	41	9	6	20	19	2	15	12	3	52	5	1	36	13
15	13	11	13	13	31	10	6	01	19	2	26	11	3	47	5	1	50	14
			12			11			19			11			5			12
16	13	23		13	20		5	42		2	37		3	42		2	02	
17	13	35	12	13	09	11	5	23	19	2	48	11	3	35	7	2	14	12
18	13	46	11	12	57	12	5	04	19	2	57	9	3	28	7	2	26	12
19	13	57	11	12	45	12	4	46	19	3	06	9	3	21	7	2	38	12
20	14	06	9	12	31	14	4	27	19	3	15	9	3	13	8	2	50	12
			9			14			19			8			9			12
21	14	15		12	17		4	08		3	23		3	04		3	02	
22	14	23	8	12	04	13	3	50	18	3	30	7	2	56	8	3	14	12
23	14	29	6	11	56	14	3	31	19	3	37	7	2	47	9	3	25	11
24	14	35	6	11	37	13	3	12	19	3	44	7	2	37	10	3	35	10
25	14	40	5	11	22	15	2	53	19	3	50	6	2	28	9	3	45	10
			4			16			18			5			10			12
26	14	44		11	06		2	35		3	55		2	18		3	57	
27	14	48	4	10	56	16	2	16	19	3	59	4	2	07	11	4	07	10
28	14	50	2	10	34	16	1	58	18	4	03	4	1	56	11	4	17	10
29	14	51	1				1	41	17	4	07	3	1	45	11	4	25	8
30	14	52	1				1	24	17	4	10	3	1	34	11	4	33	8
31	14	53	1				1	07	17				1	22	12			

A Table of Æquation of Natural Days.

Day	July.	X	Auguſt	X	Sept.	X	Octob.	X	Novemb	X	Decemb	X
	′ ″	″	′ ″	″	′ ″	″	′ ″	″	′ ″	″	′ ″	″
1	4 . 43	8	4 . 36	9	3 . 41	21	13. 13	13	15. 28	8	5 . 51	28
2	4 . 51	7	4 . 27	9	4 . 02	21	13. 26	14	15. 20	9	5 . 23	28
3	4 . 58	7	4 . 18	12	4 . 23	21	13. 40	13	15. 11	10	4 . 55	29
4	5 . 5	7	4 . 06	11	4 . 44	20	13. 53	13	15. 01	10	4 . 26	30
5	5 . 12		3 . 55		5 . 04		14. 06		14. 51		3 . 56	
		6		11		20		13		12	Subſtract	29
6	5 . 18	6	3 . 44	13	5 . 24	21	14. 19	12	14. 39	13	3 . 27	29
7	5 . 24	5	3 . 31	13	5 . 45	20	14. 31	11	14. 26	13	3 . 58	30
8	5 . 29	4	3 . 18	13	6 . 05	21	14. 42	10	14. 13	13	2 . 28	30
9	5 . 33	4	3 . 05	13	6 . 26	20	14. 52	09	14. 00	15	2 . 58	30
10	5 . 37		2 . 52		6 . 46		15. 01		13. 45		1 . 28	
		4	Add	14		21		9		16		30
11	5 . 41	3	2 . 38	14	7 . 07	21	15. 10	8	13. 29	16	0 . 58	31
12	5 . 44	2	2 . 24	16	7 . 28	21	15. 18	8	13. 13	17	0 * 28	30
13	5 . 46	2	2 . 08	16	7 . 49	20	15. 26	8	12. 56	18	0 . 03	30
14	5 . 48	1	1 . 52	16	8 . 09	22	15. 34	6	12. 38	19	0 . 33	30
15	5 . 49		1 . 36		8 . 30		15. 40		12. 19		1 . 03	
	Add	0		16	Subſtract	20	Subſtract	6	Subſtract	19		30
16	5 . 49	0	1 . 20	16	8 . 50	19	15. 46	5	12. 00	21	1 . 33	29
17	5 . 49	1	1 . 04	17	9 . 09	20	15. 51	4	11. 39	21	2 . 02	30
18	5 . 48	1	0 . 47	17	9 . 29	19	15. 55	3	11. 18	22	2 . 32	29
19	5 . 47	2	0 . 30	18	9 . 48	18	15. 58	2	10. 56	22	3 . 01	30
20	5 . 45		0 . 12		10. 6		16. 00		10. 34		3 . 31	
		2	*	17		19		2		23		29
21	5 . 43	3	0 . 05	19	10. 25	19	16. 02	1	10. 11	24	+ 00	28
22	5 . 40	4	0 . 24	19	10. 44	19	16. 03	1	9 . 47	24	+ Add 28	28
23	5 . 36	4	0 . 43	20	11. 03	17	16. 04	0	9 . 23	24	4 . 56	27
24	5 . 32	4	1 . 03	19	11. 20	17	16. 04	2	8 . 59	25	5 . 23	27
25	5 . 28		1 . 22		11. 37		16. 02		8 . 34		5 . 50	
		6	Subſtract	19		17		3		26		27
26	5 . 22	7	1 . 41	19	11. 54	17	15. 59	3	8 . 08	27	6 . 17	27
27	5 . 15	7	2 . 00	20	12. 11	16	15. 56	+	7 . 41	26	6 . 44	26
28	5 . 08	8	2 . 20	20	12. 27	16	15. 52	5	7 . 15	27	7 . 10	26
29	5 . 00	7	2 . 40	20	12. 43	16	15. 4-	6	6 . 48	29	7 . 36	24
30	4 . 53	8	3 . 00	20	12. 59		15. 41	7	6 . 19		8 . 00	24
31	4 . 45		3 . 20				15. 34				8 . 24	

CALCULATION
OF
Hours and Minutes for an
HORIZONTAL-DIAL.
DUBLIN Lat. 53°. 20'.

Calculation of Hours and Minutes for an Horizontal Dial.

Dublin Lat: 53° 20'.

Time from Noon	Hour dist. on the Plain	Time from Noon	Hour dist. on the Plain	Time from Noon	Hour dist. on the Plain	Time from Noon	Hour dist. on the Plain
h '	° '	h '	° '	h '	° '	h '	° '
XII. 00	00 . 00	XII. 30	6 . 1	I. 00	12 . 8	I. 30	18 . 23
1	0 . 12	31	6 . 14	1	12 . 20	31	18 . 35
2	0 . 24	32	6 . 26	2	12 . 33	32	18 . 48
3	0 . 36	33	6 . 38	3	12 . 45	33	19 . 1
4	0 . 48	34	6 . 50	4	12 . 57	34	19 . 14
5	1 . 0	35	7 . 2	5	13 . 9	35	19 . 27
6	1 . 12	36	7 . 14	6	13 . 22	36	19 . 39
7	1 . 24	37	7 . 27	7	13 . 34	37	19 . 52
8	1 . 36	38	7 . 39	8	13 . 47	38	20 . 4
9	1 . 48	39	7 . 51	9	13 . 59	39	20 . 17
10	2 . 0	40	8 . 3	10	14 . 11	40	20 . 30
11	2 . 12	41	8 . 15	11	14 . 24	41	20 . 43
12	2 . 25	42	8 . 28	12	14 . 37	42	20 . 56
13	2 . 37	43	8 . 39	13	14 . 49	43	21 . 9
14	2 . 49	44	8 . 51	14	14 . 1	44	21 . 22
15	3 . 1	45	9 . 4	15	15 . 14	45	21 . 35
16	3 . 13	46	9 . 16	16	15 . 26	46	21 . 48
17	3 . 25	47	9 . 28	17	15 . 39	47	22 . 1
18	3 . 37	48	9 . 40	18	15 . 51	48	22 . 14
19	3 . 49	49	9 . 52	19	16 . 4	49	22 . 27
20	4 . 1	50	10 . 5	20	16 . 17	50	22 . 40
21	4 . 13	51	10 . 17	21	16 . 29	41	22 . 53
22	4 . 25	52	10 . 29	22	16 . 41	52	23 . 6
23	4 . 37	53	10 . 42	23	16 . 54	53	23 . 19
24	4 . 49	54	10 . 54	24	17 . 7	54	23 . 32
25	5 . 1	55	11 . 6	25	17 . 20	55	23 . 45
26	5 . 13	56	11 . 18	26	17 . 32	56	23 . 58
27	5 . 25	57	11 . 31	27	17 . 45	57	24 . 11
28	5 . 37	58	11 . 43	28	17 . 57	58	24 . 24
29	5 . 49	59	11 . 55	29	18 . 10	59	24 . 38
30	6 . 1	60	12 . 8	30	18 . 23	60	24 . 51

Calculation of Hours and Minutes for an Horizontal Dial.

Dublin Lat: 53° 20′.

Time from Noon	Hour dist. on the Plain	Time from Noon	Hour dist. on the Plain	Time from Noon	Hour dist. on the Plain	Time from Noon	Hour dist. on the Plain
h ′	° ′	h ′	° ′	h ′	° ′	h ′	° ′
II.00	24 . 51	II.30	31 . 37	III. 00	38 . 44	III. 30	46 . 16
1	25 . 5	31	31 . 51	1	38 . 59	31	46 . 32
2	25 . 18	32	32 . 4	2	39 . 14	32	46 . 47
3	25 . 31	33	32 . 18	3	39 . 28	33	47 . 3
4	25 . 44	34	32 . 32	4	39 . 43	34	47 . 19
5	25 . 57	35	32 . 46	5	39 . 57	35	47 . 35
6	26 . 10	36	33 . 0	6	40 . 12	36	47 . 50
7	26 . 24	37	33 . 14	7	40 . 27	37	48 . 5
8	26 . 38	38	33 . 28	8	40 . 42	38	48 . 21
9	26 . 51	39	33 . 43	9	40 . 57	39	48 . 37
10	27 . 4	40	33 . 57	10	41 . 12	40	48 . 53
11	27 . 18	41	34 . 11	11	41 . 27	41	49 . 9
12	27 . 31	42	34 . 25	12	41 . 42	42	49 . 25
13	27 . 44	43	34 . 39	13	41 . 57	43	49 . 40
14	27 . 58	44	34 . 53	14	42 . 12	44	49 . 56
15	28 . 11	45	35 . 8	15	42 . 27	45	50 . 12
16	28 . 25	46	35 . 22	16	42 . 42	46	50 . 28
17	28 . 39	47	35 . 36	17	42 . 57	47	50 . 44
18	28 . 52	48	35 . 50	18	43 . 12	48	51 . 0
19	29 . 6	49	36 . 5	19	43 . 27	49	51 . 16
20	29 . 19	50	36 . 19	20	43 . 42	50	51 . 33
21	29 . 33	51	36 . 34	21	43 . 57	51	51 . 49
22	29 . 47	52	36 . 48	22	44 . 13	52	52 . 5
23	30 . 0	53	37 . 2	23	44 . 29	53	52 . 21
24	30 . 14	54	37 . 17	24	44 . 44	54	52 . 37
25	30 . 28	55	37 . 31	25	44 . 59	55	52 . 54
26	30 . 41	56	37 . 46	26	45 . 15	56	53 . 10
27	30 . 55	57	38 . 0	27	45 . 30	57	53 . 26
28	31 . 9	58	38 . 15	28	45 . 45	58	53 . 43
29	31 . 23	59	38 . 29	29	46 . 1	59	53 . 59
30	31 . 37	60	38 . 44	30	46 . 16	60	54 . 15

Calculation of Hours and Minutes for an Horizontal Dial:
Dublin Lat: 53° 20′.

Time from Noon	Hour dist. on the Plain	Time from Noon	Hour dist. on the Plain	Time from Noon	Hour dist. on the Plain	Time from Noon	Hour dist. on the Plain
h ′	° ′	h ′	° ′	h ′	° ′	h ′	° ′
IIII. 00	54 . 15	IIII. 30	62 . 42	V. 00	71 . 32	V. 30	80 . 40
1	54 . 32	31	62 . 59	1	71 . 50	31	80 . 59
2	54 . 48	32	63 . 16	2	72 . 8	32	81 . 18
3	55 . 5	33	63 . 33	3	72 . 26	33	81 . 37
4	55 . 21	34	63 . 51	4	72 . 44	34	81 . 55
5	55 . 37	35	64 . 8	5	73 . 2	35	82 . 14
6	55 . 54	36	64 . 26	6	73 . 20	36	82 . 32
7	56 . 11	37	64 . 43	7	73 . 38	37	82 . 51
8	56 . 28	38	65 . 1	8	73 . 56	38	83 . 9
9	56 . 45	39	65 . 18	9	74 . 14	39	83 . 28
10	57 . 1	40	65 . 36	10	74 . 33	40	83 . 47
11	57 . 18	41	65 . 53	11	74 . 51	41	84 . 5
12	57 . 35	42	66 . 11	12	75 . 9	42	84 . 24
13	57 . 51	43	66 . 28	13	75 . 28	43	84 . 43
14	58 . 8	44	66 . 46	14	75 . 46	44	85 . 2
15	58 . 25	45	67 . 4	15	76 . 4	45	85 . 20
16	58 . 42	46	67 . 22	16	76 . 23	46	85 . 38
17	58 . 59	47	67 . 39	17	76 . 41	47	85 . 57
18	59 . 16	48	67 . 57	18	76 . 59	48	86 . 16
19	59 . 32	49	68 . 14	19	77 . 17	49	86 . 34
20	59 . 49	50	68 . 32	20	77 . 36	50	86 . 53
21	60 . 7	51	68 . 50	21	77 . 55	51	87 . 11
22	60 . 24	52	69 . 8	22	78 . 13	52	87 . 31
23	60 . 41	53	69 . 26	23	78 . 31	53	87 . 50
24	60 . 58	54	69 . 44	24	78 . 50	54	88 . 9
25	61 . 15	55	70 . 2	25	79 . 8	55	88 . 28
26	61 . 32	56	70 . 20	26	79 . 27	56	88 . 47
27	61 . 50	57	70 . 38	27	79 . 45	57	89 . 6
28	62 . 7	58	70 . 56	28	80 . 4	58	89 . 25
29	62 . 24	59	71 . 14	29	80 . 22	59	89 . 44
30	62 . 42	60	71 . 32	30	80 . 40	60	90 . 00

N

A Table of the most noted *Circumpolar-Stars*, or those that set not in the *Lat*, 53°. 20'. for shewing the time of Night by a Line and Plummet, to the year 1680, and serves for 20 years to come.

Mag	Stars Names.	Rt. Ascension in Time under the Pole-star	Diff. in Time betwixt the polestar &pole	Azimuth under the Pole-star	Coast
		H ' "	H ' "	° ' "	
	Ursa Major				
2	*On his Back*	00.03.53	0 .04.26	0 .37.12	E
3	*Penult in Dracos Tail*	00.20.17	0 .03.19	0 .19.12	E
2	*Cor Caroli*	00 36 44	0 .0 .05	0 .00.54	E
2	*His Rump Aliot*	00.39.25	0 .0 .14	0 .02.06	W
2	*Middle of its Tail*	01.07.02	0 .03.44	0 .33.00	W
2	*End of the Tail*	01.28.56	0 .05.49	0 .57.00	W
2	*Last but two in Dracos Tail*	01.47.40	0 .10 58	1 .16.48	W
	Ursa Minor				
2	*Higher Guard*	02.26.05	0 .24 10	1 .55.48	W
3	*Lower Guard*	02.57.15	0 .26.50	2 .24.36	W
	Draco				
3	27 *in Ticho's Cat.*	02.59.49	0 .18.01	2 .27.00	W
3	26	03.35.17	0 .21.04	2 .55.48	W
3	25	03.54.54	0 .24.39	3 .10.12	W
3	20	03.58.34	0 .30.43	3 .12.36	W
3	24	04.36.43	0 .30.49	3 .34.48	W
3	*First in the Head*	04.59.30	0 .23.42	3 .45.00	W
2	*Bright in the Head*	05.25.01	0 .24.11	3 .53.24	W
1	*Lucida Lyra*	06.05.34	0 .20.30	4 .00.36	W

		H ' "	H ' "	° ' "	
3	*N. in the upper turn*	06.37.04	0 .35.44	4 .01.12	W
3	*S. in the upper turn*	07.11.22	0 .37.55	3 .56.24	W
	Cygnus				
3	*Upper Wing*	07.13.26	0 .21.49	3 .56.24	W
3	*Her Brest*	07.51.26	0 .19.20	3 .45.00	W
4	*N. Cepheus R. Arm*	07.55.07	0 .28.46	3 .44.00	W
2	*Swans Tail*	08.10.30	0 .19.59	3 .37.12	W
	Cepheus				
4	*S. on his R. Arm*	08.11.32	0 .26.57	3 .36.36	W
2	*Right-shoulder*	08.45.35	0 .25.02	3 .18.36	W
3	*His Girdle*	08.53.30	0 .30.44	3 .13.48	W
4	*N. in his Cap*	09.41.52	0 .18.16	2 .40.48	W
4	*Before his Head*	10.09.17	0 .15.56	2 .19.12	W
4	*Left shoulder*	10.20.44	0 .17.48	2 .09.36	W
3	*His Knee*	11.10.00	0 .17.59	1 .25.48	W
	Cassiopea				
3	*Her Chair*	11.46.07	0 .05.54	0 .51.00	W
4	*Seat of the Chair*	12.11.48	0 .03.14	0 .25.48	W
4	*Head*	12.17.20	0 .02.07	0 .20.24	W
3	*Brest*	12.20.48	0 .01.50	0 .16.48	W
4	*Girdle*	12.28.46	0 .00.59	0 .09.00	W
3	*Hipp*	12.37.50	0 .00.02	0 .00.10	W
3	*Knee*	13.08.45	0 .03.41	0 .31.12	E
3	*Legg*	13.39.38	0 .07.53	1 .01.12	E
2	*Foot of Androm.*	13.50.37	0 .06.19	1 .12.00	E

	Perseus	H ′ ″	H ′ ″	o ′ ″	
4	*Left shoulder*	14.33.32	0 .10.52	1 .51.36	E
3	*Bend of his side*	14.43.40	0 .11.03	2 .00.36	E
3	*Right shoulder*	14.55.31	0 .13.42	2 .10.48	E
3	*Medusa's Head*	14.59.14	0 .11.45	2 .13.48	E
					E
2	*Bright * in his side*	15.14.59	0 .14.29	2 .26.24	E
4	*Left Thigh*	15.37.56	0 .14.35	2 .44.24	E
3	*Left Knee*	15.51.39	0 .14.57	2 .54.36	E
4	*Before his Right Knee*	16.01.08	0 .18.05	3 .00.36	E
4	*Middle of his Right Knee*	16.09.47	0 .18.06	3 .06.36	E
	Auriga				
4	*Left Elbow*	16.58.15	0 .19 27	3 .33.36	E
1	*Capella*	17.13.55	0 .20.49	3 .40.48	E
2	*Right shoulder*	17.58.07	0 .21.55	3 .55.12	E
	Ursa Major				
4	*His Lipp*	20.31.52	0 .27.38	3 .37.48	E
3	*N. in his Right Foot*	20.50.49	0 .20.53	3 .28.12	E
3	*S. in the same*	20.55.23	0 .20.13	3 .21.00	E
3	*Left Knee*	21.24.15	0 .19.57	3 .07.12	E
4	*Higher in his hind Foot*	22.11.32	0 .13.56	2 .30.36	E
2	*Lower Leader in* □	22.54.50	0 .12.57	1 .50.24	E
2	*Higher Leader*	22.57.59	0 .14.20	1 .47.24	E
3	*Last in Draco's Tail*	23.24.13	0 .13.36	1 .20.24	E
2	*Bears Left Thigh*	23.43.36	0 .06.38	0 .59.24	E

FINIS.